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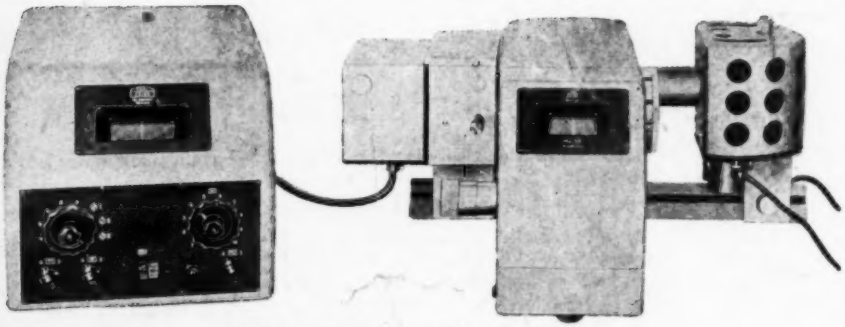

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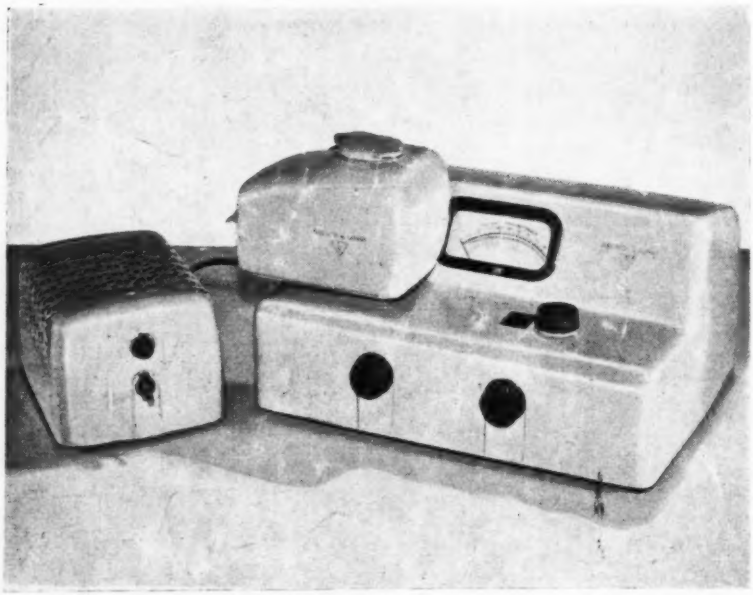

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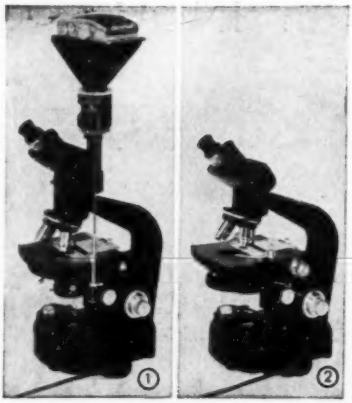

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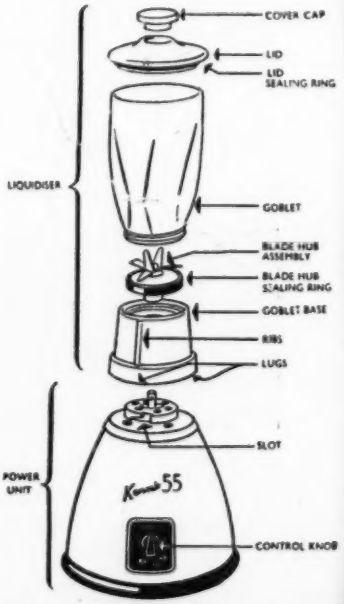

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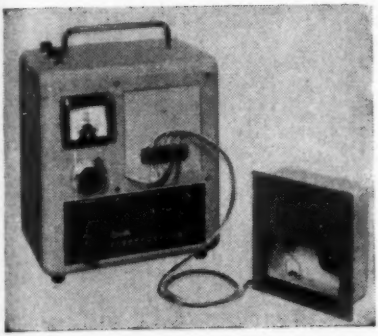

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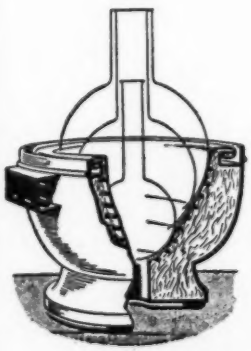

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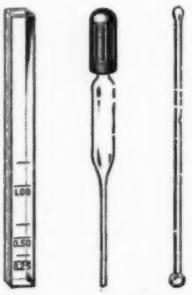

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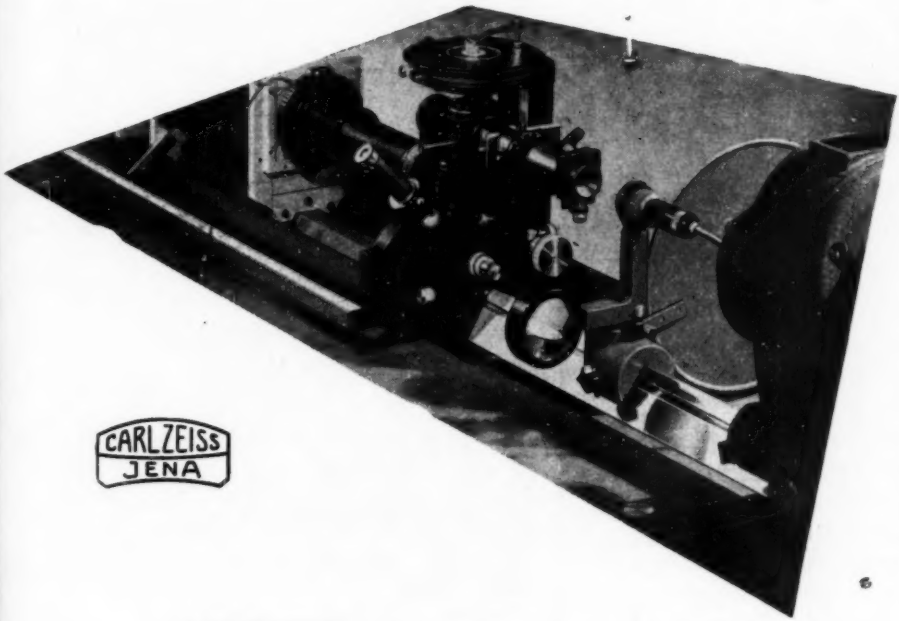

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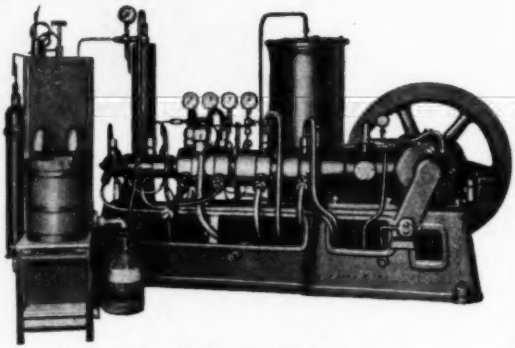

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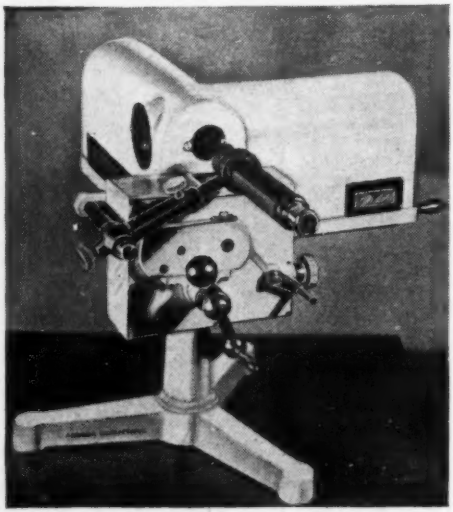

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CHRISTIAAN HUYGHENS AND THE WAVE THEORY OF LIGHT: Part I

SIR C. V. RAMAN

1. INTRODUCTION

THE world, as we perceive it, is pictured for us by the rays of light which proceed from each point of the objects around us and form images of these objects on the retinæ of our eyes—a statement which needs no amendment even when the aid of optical instruments such as the telescope or the microscope is invoked to enlarge our powers of vision. To put it a little differently, the principles of geometrical optics suffice to describe the behaviour of light as commonly experienced—*viz.*, that the rays of light are propagated in straight lines; that the angles of incidence and of reflection are equal; and that in refraction the rays of light are bent according to the law of sines. In his celebrated *Traite de la Lumiere* published in the year 1690, Christiaan Huyghens showed that these facts of experience are consistent with the hypothesis that light is in the nature of wave-motion propagated through space and can indeed be satisfactorily explained on the basis of that hypothesis. The treatise of Huyghens contains much other material of importance; a perusal of it leaves on the mind of the reader the impression that it is a masterpiece of scientific thought and exposition which possesses an enduring value and interest.

In connection with some experimental studies on the diffraction of light undertaken by the present author—the results of which will be published in the *Proceedings of the Indian Academy of Sciences*—the need was felt for a careful study of the original ideas of Huyghens. The task was made much easier by using the literal translation of his treatise from the original French into English by Sylvanus P. Thompson published by the Chicago University Press in the year 1912. The results of the study were surprising; it emerged that the ideas put forward by Huyghens in the first three chapters of his book are far from being what they have been represented to be by later writers. It also became clear that this misunderstanding of Huyghens' ideas invalidates a great deal of what has been written about the so-called "Principle of Huyghens" and especially the use made of it for the explanation of the phenomena of diffraction of light. It is the object of the present communication to give a *precis* of the contents of the first three chapters of Huyghens' treatise. In the second part of this communication, some comments on the writings of later authors relating thereto will be presented.

2. THE NATURE OF LIGHT

In the first few pages of his book Huyghens set out the considerations which led him to infer that light is in the nature of a movement which spreads into space in all directions from a luminous source. He remarks that the terrestrial sources which are observed to emit light such as fire or flame evidently contain bodies in rapid motion. Then again, when sunlight is collected by a concave mirror and concentrated on material objects, it has the same effects as fire, *viz.*, it disunites the particles of those objects. It is therefore natural to suppose that light is itself some kind of motion and that the sensation of light is excited when such movement is communicated to the nerves at the back of the human eye. Huyghens also remarks on the extreme speed with which light spreads on every side and on the circumstance that when light comes from different regions, even from those directly opposite each other, the rays traverse one another without hindrance. The facts indicate that light is a movement transmitted through space and not a transport of matter which reaches the eye from the source of light.

To account for the very high velocity of propagation of light—known from the observations of Römer on the eclipses of Jupiter's satellites—and the fact that light can pass through empty space, Huyghens proposed a physical picture of the ætherial medium which could explain its power to transmit waves with such high velocity. He suggested that the æther of space consists of an immense number of extremely small and extremely hard spherical particles in close contact with each other. Experiments on the percussion of elastic solid spheres on each other show that a medium of the nature postulated could propagate waves simultaneously in all directions with high velocity and in such manner that waves travelling in different directions at one and the same time would not hinder each other's progress. Huyghens further recognized that every luminous object would necessarily contain an immense number of centres emitting

light and that from each of such centres thousands of waves might emerge in the smallest imaginable time ; he pointed out that these considerations would make it easier to understand, why in spite of the enfeeblement of the individual waves by their spread through immense distances, the light of the distant stars continues to be perceptible to human eyes.

3. The Rectilinear Propagation of Light

The mechanical model of the æther proposed by Huyghens to account for the propagation of waves of light through it also enabled him to give a simple and satisfactory explanation of why light travels out from the original source in straight lines. Considering the medium which transmits light to be composed of an immense number of very small and very hard spherical particles in close contact with each other, it follows that each of these particles when it is displaced from its position by the passage over it of the parent wave sent out from the original source would itself function as the source of a wave which spreads out from it in all directions. The particular or partial waves of this nature recognized by Huyghens in his argument would be as numerous as the total number of the individual particles of æther contained in a sphere drawn with the source of the primary wave as centre and the distance to which it has travelled out as the radius. It is evident, also, that these partial waves, though present in enormous numbers within the volume of the sphere, would individually be of excessively feeble force. In theory, they are assumed to travel out from their respective centres in all directions but actually, by reason of their excessive feebleness the effect of all the partial waves may be totally ignored except of those which arrive together at the same instant, in other words, *simultaneously*, at the point of observation. For, in the latter case, their effects would be superposed and would add up to give an observable result. Such simultaneity in arrival and consequent superposition of effects would be possible only in the case of those partial waves which originate at points in the medium between the primary source of light and the point of observation which lie on the straight line joining them. The summation of the partial waves originating at such points and reaching the point of observation at the same instant would produce the luminous effect there observed. Thus the light which reaches the point of observation from the original source may be considered as having travelled out along the straight line joining the two points.

4. The Reflection and Refraction of Light

In the second and third chapters of his treatise, Huyghens considered the phenomena which arise when light travelling in one medium reaches the boundary which separates it from another. In considering those phenomena, various physical questions arise and are discussed by him, as for example, why some materials are transparent to light and others are opaque, why the velocity of light in a material medium should differ from that in empty space and what the actual configuration of the boundary of the separation between two media is or can be.

The explanation of reflection and refraction in terms of the wave hypothesis is based on an idea which Huyghens found himself compelled to introduce, *viz.*, *that the elements of the area* of the boundary of separation between the two media act as sources of partial waves which travel out respectively into the two media. The partial waves returned from the boundary into the first medium build up the regularly reflected wave, while those travelling into the second medium give the refracted wave.

A simple geometric construction based on the foregoing ideas enabled Huyghens to explain the familiar law of reflection of light. Likewise, assuming the second medium to be transparent and that the velocity of light in it differs from that in the first, a similar geometric construction led him to the result that the sine of the angle of incidence and the sine of the angle of refraction bear to each other a constant ratio which is the same as the ratio of the velocities of light in the two media. The phenomena of the total internal reflection of light also found a satisfactory explanation. Huyghens showed further that his construction leads directly to Fermat's principle of minimum time for the passage of light from one point to another when the two points are in different media.

GOLDEN JUBILEE OF THE INDIAN INSTITUTE OF SCIENCE, BANGALORE

THE Golden Jubilee of the Indian Institute of Science, marking its 50 years of progress (1909-59), was celebrated with *eclat* during a week from the 2nd to the 8th February 1959. It was inaugurated by Dr. Rajendra Prasad, President of India, on the 2nd, before a gathering of over 6,000 people. The celebration coincided with the visit to India of His Royal Highness the Duke of Edinburgh and his participation in the inaugural function added importance to it. Among those who took part in the celebrations were His Highness Sri Jayachamaraja Wadiyar, Governor of Mysore, Dr. S. Radhakrishnan, Vice-President of India, Prime Minister Pandit Jawaharlal Nehru and Prof. Humayun Kabir, Union Minister for Scientific Research and Cultural Affairs. A large number of distinguished scientists from abroad, who brought messages of greetings from the scientific organizations of their countries to the Institute on this occasion, attended the celebrations.

President Rajendra Prasad in inaugurating the celebration paid a glowing tribute to the late Mr. J. N. Tata who more than sixty years ago foresaw the requirements of an industrialized India and with forethought, wisdom and patriotism founded this Institute. Speaking about the impact of science on material progress Dr. Rajendra Prasad referred to the dilemma of science and said that science cannot be called a blessing without recognising its social obligations and moral principles, and he stressed on the urgent need of tempering scientific progress with spiritual or moral values.

As Visitor of the Institute, the President announced his approval of the conferment of honorary Fellowships of the Institute on Prime Minister Nehru, Dr. C. V. Raman and Dr. M. Visvesvaraya.

The Duke of Edinburgh in his speech referred to the crisis which science has produced and said that "we can solve it by our own choice, or, if we don't, it will certainly be solved for us by war or by famine". Speaking on the role of centres of learning, the Duke said, "It seems to me it is the clear duty of all institutes of higher learning to do what they can to help the world make the right choice".

Earlier, Mr. J. R. D. Tata, President of the Court of the Institute, who presided over the inaugural function, in his welcome speech, recounted the progress of the Institute since its inception and stressed the need for the Institute to identify itself with the task of national reconstruction.

Dr. S. Bhagavantam, Director of the Institute, while proposing a vote of thanks, referred to the needs of science and technology in India today and made a strong plea for the establishment "in a big way" of an Instrument-making centre in the country.

Prof. Humayun Kabir opened the Golden Jubilee Exhibition, at 4 p.m., on the 2nd February. His Highness the Governor of Mysore opened the New Wind Tunnel of the Aeronautics Department of the Institute on the 3rd February.

Dr. S. Radhakrishnan, Vice-President of India, in his address on the 3rd evening, speaking about Science and Religion, said "Science would help humanity to overcome superstition and ignorance, while religion would help them to overcome selfishness, jealousy and greed. If these two worked hand in hand, the world would have an integrated human being—a being who belonged to the future and not to the present".

Prime Minister Nehru, who addressed a meeting on the 4th February, referred to the problem of conveying scientific knowledge to the people, and to the problem of the language of science which will "not only enable the country to keep pace with the scientific progress abroad but also will help people to develop a scientific way of thinking". He dwelt on the need for a common scientific terminology and said that efforts should be made for evolving a terminology which should be common to all the Indian languages and added that international scientific terms should also be adopted for usage, otherwise it would be impossible for the country to advance in the field of science and technology.

In an evening public lecture on the 4th February, Dr. H. J. Bhabha, Director, Tata Institute of Fundamental Research, spoke on "the Economics and Development Programme of Nuclear Energy for Power Production in our National Plan". In a public lecture, on the 5th evening Dr. K. S. Krishnan, Director of the National Physical Laboratory, spoke on "The Progress of Physics at the Turn of the Century".

There were also a number of scientific and technical lectures arranged in different Departments during the week in which the foreign scientists present addressed scientific gatherings. These included Prof. G. Rienacker (W. Germany), Mr. P. Danel (Holland), Prof. A. Tiselius, N.L. (Sweden), Mr. J. H. Pitchford (England), Dr. A. E. Douglas (Canada), Dr. K. F. Meyer (U.S.A.), Prof. F. Hawking (England), Prof. Hans Friedrich-Freksa (Germany), Dr. Neil Hutcheon (Canada), Prof. L. Janossey (Hungary), Dr. W. T. J. Morgan (England) and Mr. Paul O'Langguth (Bombay).

The Exhibitions arranged by the various Departments of the Institute proved to be of great interest and educative value and daily attracted large crowds of visitors. Originally scheduled to close on the 8th February, they had to be extended for three more days to meet the public demand.

The Golden Jubilee Celebrations have left a deep impression on all those who attended them and Dr. S. Bhagavantam, Director of the Institute, his staff and students deserve the warmest congratulations for the unqualified success of the celebrations. We have no doubt that with such happy auguries ushering in the new era of the second fifty years, we can confidently look forward to a period of rapid development in the activities of the Institute.

THE INDIAN SCIENCE CONGRESS

THE 46th Annual Session of the Indian Science Congress was held in Delhi from 21st to 28th January 1959 under the auspices of the University of Delhi. The Session was inaugurated by Prime Minister Nehru and was presided over by Dr. A. Lakshmanaswami Mudaliar, Vice-Chancellor of the Madras University. About 3,000 delegates from all over the country and 85 from abroad attended the Session.

His Royal Highness the Duke of Edinburgh who led the British team of delegates to the Congress conveyed greetings and good wishes from the Queen and from the British Association for the Advancement of Science.

In his Inaugural Address the Prime Minister said that "broadly speaking science had driven out many of the Gods before whom people bowed and itself assumed a Godlike pose..... Like two-headed Janus it shows the face of the Creator and the face of the Destroyer". He further remarked that "Science has to look at the heart and mind of man and integrate this knowledge with the other advances it is making".

Dr. Lakshmanaswami Mudaliar in his Presidential Address spoke on the beneficial role played by modern science in promoting human welfare and, what is more, in preventing human ills, and dwelt in detail about the progress of medicine within the last fifty years and how medical science has been influenced and guided by the great discoveries in physical, biological and technological sciences.

About 1,500 papers contributed to the Session were taken up for presentation in the thirteen sectional meetings each presided over by the Sectional President.

Besides reading of papers there were symposia and public lectures. There were two Exhibitions: The Scientific and Technical Instruments Exhibition and the Exhibition of Scientific Literature in the fourteen Indian Languages. The latter was opened by Mr. C. D. Deshmukh, Chairman of the University Grants Commission. The bulk of the literature represented popular science, school-books and children's literature.

The 47th Session of the Congress will be held in Bombay in January 1960. Prof. P. Parija, Vice-Chancellor of the Utkal University, has taken over as General President for 1959-60.

IRELAND'S TRIBUTE TO HAMILTON, THE DISCOVERER OF QUATERNIONS

A PLAQUE commemorating the discovery of Quaternions by Sir William Rowan Hamilton, the great Irish mathematician, was unveiled at Rowan Hamilton Bridge, formerly Broome Bridge, Cabra, on the 13th November 1958 by the Taoiseach, Mr. de Valera. The story goes that on the 16th October 1843, when Hamilton was walking along the tow path of the Broome Bridge, there suddenly occurred to him the solution of a problem which had been occupying his mind for a considerable time. With a penknife he worked out the solution on one of the stones of the bridge. That marked the birth of the quaternions. Paying a tribute to the memory of a great scientist and a great Irishman, Mr. de Valera said, "On many occasions since I first heard this story well over 50 years ago, I came to this bridge as to a holy place. I have searched stone after stone in the hope of finding some trace of that famous inscription. .....Time had done its work but they were gathered there now to see that that inscription would be perpetuated and that those who passed there would remember that they were passing by a spot that was famous in the history of science".

There could be no question of the profound importance of what Hamilton had discovered on that day in October 1843. It was nothing less than a new era of mathematical thought, without which the theoretical development of modern physics would have been well-nigh impossible. As Schrœdinger had said "Hardly a day passes, hardly an hour passes, that somebody somewhere on this globe does not pronounce the name of Hamilton, or reads it or writes it or prints it".

INDIAN FISHERIES*

By N. K. PANIKKAR

Fisheries Development Adviser to the Government of India

THE fishery resources of India include marine, estuarine and fresh water fisheries consisting of a very large number of species. Our present sea fish production is of the order of 7 to 8 lakh tons per annum and it is estimated that another 3 lakh tons of fish are produced in inland waters. There is in addition a considerable amount of subsistence fishing. This production is high and places India among the first seven nations having annual production of over a million tons. In 1957 our catch from marine and inland sources totalled about 12 lakh tons which is a very substantial increase over those of previous years. This is, however, inadequate to meet the country's needs which may be roughly computed at about 40 lakh tons per annum. The national income from fisheries is estimated at about 50 crores of rupees per annum and overseas trade in fish and fish products secures for the country about 3 to 5 crores of rupees as foreign exchange.

The sea fisheries resources comprise a large variety of fishes the most important of which are Sardines, Mackerel and Prawns. Many other esteemed varieties exist, particularly pomfrets and seer fish. Fishing is generally confined to the narrow coastal belt of about 6 to 10 miles from the coast and production is in the hands of nearly a million fishermen. Coastal fisheries are largely seasonal which accounts for surplus in some months with the attendant problems of transportation, marketing, processing and storage. The West Coast of India at present accounts for well over two-thirds of our total sea fish production. Exploratory fishing has shown that there are rich deep sea fishing grounds off Kathiawar and extensive prawn resources exist off Bombay and Cochin.

As a result of researches on marine fisheries at the Central Marine Fisheries Station, Mandapam, for the past ten years, we now have a fairly accurate idea of our present sea fish production, important species and regions of the coast where they are found and their seasonal variations. Considerable progress has been made in the study of the biology of important commercial species and in the augmentation of coastal fishery resources by culture and farming practices. Latent resources in sea weeds and molluscan fisheries have been investigated to give some idea of their value in future development. Basic data on the productivity of the Indian seas, oceanographical conditions and their relation to fisheries are being obtained in an effort to understand and thereby foresee the magnitude and variations of the more important sea fisheries.

The pronounced difference between the West and East Coasts of India in respect of fish landings is associated with the oceanographic conditions prevailing in the Arabian Sea and the Bay of Bengal. The Arabian Sea is an area subjected to continual replenishment of the dissolved nutrients of the surface through the upwelling of deeper waters, the coastal currents and the stress on inshore waters through the strong mansoon winds. There is further a reversal of winds and currents between the South-West and North-East monsoons. Plankton studies have indicated a high degree of productivity in waters off Kerala Coast as compared with the coastal waters of Mandapam and Madras.

The inland fisheries resources consist of the capture fisheries of the large number of rivers, lakes, irrigation dams, etc., and the culture fisheries in the thousands of fish ponds scattered throughout India. Fish cultural practices are particularly developed in Bengal, Bihar and Orissa, where there is an organised fish culture industry. Efforts in inland fisheries development lie in extending fish culture to all parts of India and in the adoption of scientific methods of fish farming. An acre of cultivated fish pond will yield, without artificial feeding, a quantity of about 1000 lb. of fish per acre per annum as against about 200 lb. from fish ponds not subject to cultural practices. Several lakhs of acres of water are now remaining fallow but with effort, all these could be brought to yield a regular harvest.

A major problem here is that the important culture fishes of India, *viz.*, the major carps, Rohu (*Labeo rohita*), Mrigal (*Cirrhina mrigala*) and Catla (*Catla catla*) do not breed in the confined waters where they are cultured. Fish culture industry is, therefore, dependent upon naturally occurring spawn and fry for stocking purposes. As the spawning period is confined to the monsoon months (June-August) and the spawning areas confined to certain portions of rivers or adjoining waters subject to flooding,

* Summary of a public lecture given before the 24th Annual Meeting of the Indian Academy of Sciences, held at Baroda, on 28th December 1958.

the available fish seed is limited. Researches at the Central Inland Fisheries Station have helped to reduce the mortality of fish seed while they are collected and transported. A promising line of work has been successfully opened up whereby the carps have been induced to spawn in the ponds by the administration of pituitary hormone.

The estuarine fisheries mainly consist of capture fisheries in the coastal tracts like Chilka and Pulicat Lakes, large numbers of backwaters on the coasts and estuaries of the large rivers. Important estuarine fishes are Bhekti (*Lates calcarifer*), mullets (*Mugil* spp.), milk fish (*Chanos chanos*) and prawns.

A large part of our sea fish catches is seasonal and based on shoaling species like Sardines and Mackerel. This fact combined with the inadequacy of transportational facilities to send fish in fresh condition to the interior, has led to the development of a fish curing industry. The surplus catches are either sun-dried or salt cured and later sun-dried. Prawns are often boiled and sun-dried. Pit-curing and wet-curing by different methods are also practised throughout India, but the curing industry is best developed on the Kanara, Konkan and Malabar coasts. Recently, cold storage and ice plants have been established in various places and private industry has come into the field of freezing good quality prawns and fish. The bulk of cured fish produced in India is exported to Ceylon and other eastern countries and there is a growing market for frozen shrimp in the United States. In addition, small quantities of fish meal, fish guano, fish manure and fish oil have been exported to other countries for many years.

Fisheries have been looked upon for many years only as a source of revenue. It took many years to have that orientated to development and better utilisation of an important natural resource. In recent years administrative organisations to deal with fisheries have come into being in most States but much more remains to be accomplished if fishery industry is to contribute its full share to national economy.

SOME ASPECTS OF ESTUARINE HYDROLOGY AND BIOLOGY*

ESTUARIES are characterised by complexity of physical structure and pattern of circulation and ever-unsettled hydrological features. Studies of the vellar estuary (Lat. 11·29° N and Long. 79° 49° E) which is a bar-built estuary and always open to the sea show that it can be demarcated into (1) *a marine zone* with homogeneous salinity, (2) *a tidal zone* with higher salinity at the bottom and lower salinity at the surface, and with the difference between the bottom and surface salinities progressively increasing up the estuary and (3) *a gradient zone* with the difference in salinity progressively diminishing up the estuary, and which merges into (4) *the freshwater zone*. The existence of a stratification into an upper less saline and a lower more saline layer in this bar-built estuary makes it difficult to fit it into the generally accepted schemes of classification of estuaries. There is need for critical studies of the hydrography of Indian estuaries.

The salinity of estuarine waters is continually changing. Hourly and two-hourly studies of the hydrobiology of the vellar estuary have been continuously made for twenty-four hours on full-moon and new-moon days. The rate of change of salinity is not uniform but varies frequently in a marked manner during the flow as well as ebb tides. This is much more marked at the surface than at the bottom. The differential rate of the continual change of salinity is very significant for organisms in relation to their physiological adaptations and distribution in the different zones of the estuary.

The dynamic state of estuarine waters is also reflected in the fluctuations in the volume and composition of plankton from hour to hour. The volume of plankton collected has its maximum during night time at low tide.

Estuarine organisms are very suitable for comparative biochemical studies. Biochemical features of the gonadial cycles of estuarine fish have been under investigation in comparison with those in other environments. The pituitary and ovary during different stages show interesting variations in their biochemical constituents like free and protein bound amino acids, amino-nitrogen, alkaline phosphatase, etc.

R. V. SESHAIYA.

* Summary of paper presented to the 24th Annual Session of the Indian Academy of Sciences, Baroda.

CYTO-GEOGRAPHY OF SOME INDIAN PLANTS*

THE Plant Geographer is concerned not only with the distribution of plants in Space but also in Time. The primary cause of changes in the distribution of plants seen in the prescnt day, lies in the variation in the distribution of climates. This again is closely related to the changes in the distribution of land and water brought about by cycles of mountain building and the Ice Ages which have always followed these revolutions.

The breaking up of the great Gondwana land and the Himalayan uplift took place after the evolution of Flowering plants. This has resulted in the dispersion of related families and genera in the continents of South America, Africa, Australia and Peninsular India, all of which formed part of this great land system.

The analysis of some genera of Indian plants has been correlated with the performance of allied plants in these regions. For this study, chromosome changes and polyploidy have been used as a measure of genetic advance. In such genera as Magnolia and Viburnum, the North Asian tribes which are all diploids, have undergone evolutionary changes resulting in new polyploid species in Eastern Himalayas.

The diploid *Nymphœa stellata* of Kerala is closely related to the *Nymphœa* of Madagascar and East Africa while the same species occur only as hexaploids in the Gangetic Plain. Hexaploids are also found in Egyptian and European species of *Nymphœa*.

The genus Buddleia probably arose in Africa where only diploids ($2n = 38$) are found in this genus and allied genera. Amongst Indian species, very high polyploids ($2n = 114$, $2n = 304$) occur in Sikkim and Assam regions.

Some of the trees belonging to Magnoliaceæ which have been identified with fossils are found to be diploids. They may therefore be considered to have remained diploids since their first appearance on the earth! This is true also of some of the *gigantic trees of the Humid Tropics of India*. We therefore, have in these regions, a vegetation which is similar to what existed on the earth during Cretaceous times.

E. K. JANAKI AMMAL.

* Summary of a lecture d l'vered at the 24th Annual Meeting of the Indian Academy of Sciences, held at Baroda, on 29th December 1958.

THE 2-METER—PLANO GRATING SPECTROGRAPH

THE first German grating spectrograph (Fig. 1) uses a Zeiss-original grating of the best resolution with 650 ruled lines per mm. on a divided area of 70×50 mm. The advantage of the chosen Ebert set-up is the stigmatic,

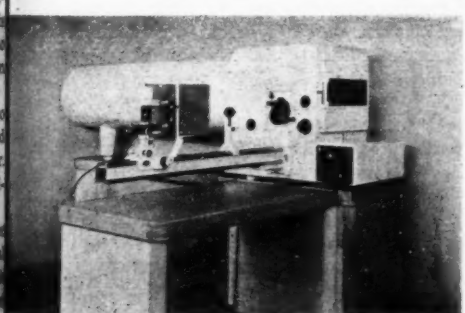


FIG. 1

nearly plane image of the spectra. The dispersion is 7·4 Å/mm. in the first order at a theoretic resolution of 45000, which is nearly obtained. At an opening proportion 1 : 30 the spectral range from 2000 to 28000 Å is covered in cut-outs of 1750 Å on the fixed plate of the length 240 mm., and in cut-outs of 2200 Å on the fixed plate of the length 300 mm. The Grating Spectrograph particularly excels in that a wavelength scale within the range of 2000-7000 Å of the first order may be copied. The shutter and the dark slide displacement adjustable in stages are operated automatically. It is possible to connect a time switching appliance. A novel and extraordinarily stable square rail takes up the spark gap and the condenser optics.

The device is mounted on a special table and embodies exacting optical performances as well as a finished appearance.

The gratings used have saw-toothed profile of the ruled lines. The "Blaze" properties are within the ultra-violet and visible of the first order with a degree of reflexation of about 70%. The relative intensity of the very weak Rowland reflexions is below 0·1% of the main line in the first order. Since the grating, may be screwed for reading within the range of $\pm 65°$, exposures of the higher order may easily be taken after the tabular adjustment of the grating.—*VEB CARL ZEISS JENA.*

STORED ENERGY IN THE GRAPHITE OF A NUCLEAR REACTOR

THE annealing of nuclear reactors to release their "stored energy" has come into the news during the past year because it was during such a release, last autumn at Windscale that an accident occurred.

What is stored energy? And how and why is it released? To answer such questions we must start with the way that a nuclear reactor works. When a uranium-235 nucleus explodes, in the process of nuclear fission, most of the energy that it releases appears as energy of motion in the pieces of the nucleus that are thrown apart by the explosion. The main pieces quickly come to rest within the fuel material itself and their energy is turned into heat. But the two or three neutrons that are also thrown off travel much farther and escape out of the fuel into the surrounding material. It is necessary to place a special substance, the "moderator", between the fuel rods to slow them down.

The moderator consists of a solid stack of large graphite blocks through which pass channels for fuel rods and cooling gas. Inside this graphite a neutron makes an irregular zigzag journey, bouncing once every few centimetres or so off the nucleus of a carbon atom that it happens to meet. Although carbon atoms are strongly held together in graphite by the forces of atomic bonding, the impact of a fast neutron on such an atom is so severe that it not only knocks the atom away from its neighbours, it also gives this atom enough energy to push its way past many other atoms and to knock about 100 others out of place before it is brought to rest again.

If they were in a liquid the displaced atoms could easily make new places for themselves amongst the general irregular swirl of atoms, by pushing others aside. But graphite is a solid, made of crystals in which the carbon atoms are regularly arranged in a hexagonal pattern in sheets stacked one on top of another. If an atom is removed from its place in this pattern, its neighbours remain in their places and an atomic-sized hole, called a "vacancy", is left in the crystal. The crystal pattern is then no longer perfect, and is said instead to be "defective". Conversely, when a displaced atom comes to rest at a place in the crystal where there is no vacancy it cannot become part of the pattern and must intrude itself into some position between the hexagonal sheets; this type of defect in the crystal is called an "interstitial". Professor E. P. Wigner of Princeton University, predicted that these vacancies and interstitials would change the properties of the material, perhaps adversely. These changes are now known to occur and are called "Wigner effects". Some of them are fairly obvious. Mechanical strength and hardness are certainly changed by such defects in a crystal; and interstitials change the shape of graphite by pushing the hexagonal sheets apart slightly.

Most of the energy lost by a fast neutron in graphite is immediately turned into heat but some of it remains "stored" in the vacancies and interstitials. When an atom is knocked out of place some energy is required to sever the atomic bonds which held it to its neighbours and some is required to strain the hexagonal sheets apart to make room locally for the interstitial. This energy is stored in the sense that so long as the vacancies and interstitials remain in the crystal, it remains with them and cannot be turned into heat. The amount of energy that can be stored in graphite in this way is surprisingly large, in extreme cases as much as one-sixteenth of the energy that would be released by burning the material. This is because the energy required to place an atom of the crystal pattern into an interstitial position is not far short of that required to evaporate it away from the crystal altogether. In fact if all the energy stored in 1% of displaced atoms could be turned into heat it would be enough to increase the temperature of graphite by more than 500° C.

It is the possibility that a sudden and large increase of temperature might take place, which could lead to excessive oxidation of the graphite and also cause damage to the fuel and other materials in the reactor, that has made stored energy an important problem in graphite-moderated reactors.

There are three general ways to deal with the stored energy problem in graphite reactors: to keep the graphite hot during running so as to avoid storing much energy; to allow the graphite to store energy but control its temperature so that a release of energy can never occur; or to allow the graphite to store energy but deliberately release this energy at intervals so as to avoid high temperatures.—*Times Science Review*, Autumn 1958.

EFFECT OF CERTAIN ORGANIC INSECTICIDES ON THE YIELD OF CROPS

D. SESHAGIRI RAO

Division of Entomology, Department of Agriculture, Bangalore

THE reaction of plant to the application of modern insecticides, *independent of the role of the latter in controlling insect infestations*, does not appear to have received adequate attention. Insecticides can affect plants in two ways; they may prove beneficial, by absorption into the system and stimulate growth, resulting in a better stand and increased yields. It has been claimed for several recent formulations that they serve as hormones in promoting growth and output of crops in addition to their more legitimate function of controlling insect pests. The second possibility is that insecticides may prove harmful to the plants, by retarding growth, causing malformations, reducing yields and so on. Much attention has been bestowed on this aspect under the broad heading 'Phytotoxicity'. Scorching, wilting, malformation, unhealthy colour and appearance, premature leaf-fall and lowered yields, are some of the obvious symptoms of Phytotoxicity. Similarly, tainting, insipidity, off-flavours, unpleasant taste, etc., are some of the manifestations when such insecticides are absorbed, translocated, and stored in the plant body. The third obvious possibility is for the concerned insecticide to have no effect on the plant, except to kill or repel insect populations.

In order to determine one particular aspect of this question, *viz.*, the effect of insecticidal treatment on the yield of the crop, a series of small-scale field trials were laid out. Small plots put under a particular crop, were sprayed with normal strengths of the selected insecticides, at definite intervals, which were shorter than are prescribed in spraying schedules. Spraying was carried on without reference to insect attack, and in fact, in most trials no insect infestation was noticed. A check plot with no treatment was maintained in each case.

The relevant data concerning the various trials are briefly furnished in the table (Series I).

Remarks.—Though 30 pieces were planted in each sub-plot a varied number of plants were killed by root grubs in the soil. A number of tubers were also seen damaged by root grubs which in some cases were found actually gnawing tubers at harvest. The weights of damaged tubers shown above are only those of the portions remaining.

SERIES I

Crop:—Potato; *Sub-plot size:*—7' × 4½'.
Planted:—7-6-1958; *Harvested:*—21-8-1958.
Insecticides:—(*a*) DDT 50% w.p.—1 lb. in 16 gallons
(*b*) Folidol—3 c.c. per gallon.
No. of treatments:—9; *Frequency:*—Weekly.

Harvest Results:—

Treatment	No. of plants	No. of Tubers		Weight of Tubers		
		Good	Damaged	Good (g.)	Damaged (g.)	Total (g.)
DDT ..	30	52	8	1327	146	1473
Folidol	18	29	6	460	137	597
Check ..	16	27	19	156	260	416

SERIES II

Crop:— Groundnut; *Sub-plot size:*—256 sq. yds
Sown:— 28-7-1958; *Harvested:*—26-11-1958
Insecticides:— (*a*) DDT 50% w.p.—1 lb. in 16 gallons
(*b*) Heptachlor—10 c.c. per gallon
(*c*) Folidol 2 c.c. do.
(*d*) Endrex 9 c.c. do.
(*e*) Basudin 10 c.c. do.
(*f*) Aldrin 10 c.c. do.

No. of treatments:— 5; *Frequency:*— Fortnightly.

Harvest Results:—

Treatment	Weight of pods harvested lb.	Variation from check	By measure (in Mysore seers)	Variation from check
DDT ..	31	−17	20	−11
Heptachlor ..	53	+ 5	34	+ 4
Folidol ..	53	+ 5	35	+ 5
Endrex ..	53	+ 5	35	+ 5
Basudin ..	55	+ 7	34	+ 4
Aldrin ..	13	−35	10	−20
Check ..	48	..	30	..
Average of 4 other bits treated as check	23	..	16	..

Remarks.—The plot is not level, but sloping from West to East with a conspicuous hump in the portion where (*e*) and (*f*) sub-plots are located.

Series III

Crop:—Potato; *Sub-plot size:*—6½′ × 6′.
Planted:—6-8-1958; *Harvested:*—7-11-1958.
Insecticides.—Heptachlor—6 c.c. per gallon.
No. of treatment:—10; *Frequency:*—Weekly.

Harvest Results :—

Treatment	No. of pieces planted	No. of tubers	Weight (g.)
Heptachlor ..	54	52	438·5
Check ..	35	39	264·0

Series IV

Crop:—Cabbage.
Sown:—21-7-1958; *Transplanted:*—8-8-1958 and 11-8-1958; *Harvested:*—18-11-1958.
Insecticides:— (*a*) DDT 50% w.p - 1 lb. in 16 gallons. (*b*) Folidol—3 c.c. per gallon.
No. of treatments:—14; *Frequency:*—Weekly.

Harvest Results :—

Treatment	Sub-plot size	No. of plants	No. of heads formed	Total weight including roots
DDT ..	8′ × 6½′	16	Nil	2·4 Kg.
Folidol ..	8′ × 7½′	16	5	7·2 Kg.
Check ..	8′ × 3′	11	Nil	0·8 Kg.

Remarks.—There is some variation in the size of the sub-plots. Due to root grub trouble in the soil, a number of plants died in the early stages. At harvest, heads had been formed only in the Folidol plot.

Series V

Crop:—Garden beans; *Sub-plot size:*—7′ × 4½′.
Sown:—23-10-1958; *Harvested:*—10, 20, 27-12-1958 and 3-1-1959.
Insecticides:— (*a*) DDT 50% w.p.—1 lb in. 16 gallons, (*b*) Folidol—3 c.c. per gallon.
No. of treatments:—8; *Frequency:*—Weekly.

Harvest Results :—

Treatment	No. of plants	No. of pods	Weight of pods (g.)
DDT ..	31	349	1254
Folidol ..	33	344	1245
Check ..	29	477	1783

Remarks.—The check plot shows more luxuriant and healthy foliage than either of the treated plots. DDT plot particularly looks off-colour, with top-leaves wrinkled at the edges.

Discussion

It is apparent that in these trials, insecticidal treatment has had a recognizable effect, beneficial or adverse, on the yield. Where the effect is beneficial, it is distinct from the advantage accruing to the plants on account of insect infestation being controlled, since there was no infestation in these trials. The reaction of the plants to the insecticide is seen in an exaggerated measure due to the greater frequency of application and perhaps higher strengths of insecticides sprayed.

In the above trials DDT and Folidol were employed in four series,—on Potato, Groundnut, Cabbage and Garden beans. On the first three crops both the pesticides have resulted in increased yields, compared to the controls. On Potato, the average yield per surviving plant is 44·2 g. (DDT), 25·5 g. (Folidol) and 9·75 g. (Control); average number of tubers per plant is 2 (DDT and Folidol) and 3 (Control), average weight of a good tuber is 25·5 g. (DDT); 16 g. (Folidol) and 5·8 g. (Control); and percentage of tubers damaged by root grubs is 13·3 (DDT), 17 (Folidol) and 43·4 (Control). Thus not only is the yield (by weight) proportionately more, but the incidence of the root grub is less, under treatment. On groundnut, while the yield of the DDT plot is less than in the check plot, it is greater than the average of the untreated portions. Folidol has given a yield much higher than the two controls. On cabbage the average weight of each plant at harvest is 150 g. (DDT), 450 g. (Folidol) and 72·7 g. (Control).

On Garden beans the results are contrary. The number of pods harvested per plant and their weight was less under treatment than in the check. Thus the average number of pods per surviving plant is 11·2 (DDT), 10·6 (Folidol) and 16·4 (Control); weight of pods harvested per plant is 40·4 g. (DDT), 37·7 g. (Folidol) and 61·5 g. (Control).

Heptachlor was sprayed on groundnut and Potato and gave better yield than the controls. On Potato while the number of tubers per plant is one, the weight of yield per plant is 8·43 g. (Heptachlor) and 6·77 g. (Control). On groundnut the yield was substantially higher under treatment compared both to the check plot and the untreated portions.

Endrex, Basudin and Aldrin were tried only on groundnut. The first two pesticides gave better results than both the check and the untreated portions. The performance of Aldrin was however conspicuously poor, but this requires confirmation by further tests.

Grateful thanks are due to Dr. M. Puttarudriah, Government Entomologist, for encouragement and helpful advice, and to Messrs. D. P. Ramanna and S. Nanjunda Sastry for kind assistance in fieldwork.

LETTERS TO THE EDITOR

EVALUATION OF FORCE CONSTANTS OF OsO_4

WOODWARD and Roberts[1] have recorded the Raman spectra of OsO_4. Using the simple valence force field, without interaction terms, they have evaluated the force constant for X-Y stretch.

Using the Wilson's F-G matrix method, the secular equations have been obtained, and five force constants have been evaluated for the molecule OsO_4.

The molecule under investigation has the point group T_d. As such by the application of group theoretical methods and the relevant selection rules such a structure yields 1 non-degenerate vibration of type A_1, 1 doubly degenerate vibration of type E, and 2 triply degenerate vibrations of type F_2. All the vibrations are Raman active.

The most general second-degree potential energy function used in this investigation is given below. It is not possible to give values for all the force constants since only four fundamental frequencies are available.

$$2V = f_d \sum_i \Delta d_i^2 + f_\alpha \sum_{i,j} (d\Delta\alpha_{ij})^2 + \tfrac{1}{2} f_{dd} \sum_{i,j} \Delta d_i \Delta d_j + 2f_{d\alpha} \sum_{i,j} (d\Delta\alpha_{ij}) \left(\sum_{k,l} d\Delta\alpha_{kl}\right) + 2f_{\alpha\alpha}' \sum_{i,j,m,n} (d\Delta\alpha_{ij})(d\Delta\alpha_{mn}) + 2f_{d\alpha} \sum_i \Delta d_i \left[\sum_{i,j} (d\Delta\alpha_{ij})\right] + 2f_{d\alpha}' \sum_i \Delta d_i \sum_{j,k} (d\Delta\alpha_{jk})$$

where $i,j = 1, \ldots 4$ and $i \neq j$
$k,l = 1, \ldots 4$ but k or l may be equal to i or j and $i = j$.
Similarly $m = n$ but m or n may be equal to i or j.

The subscripts d and α denote bond stretching and bond bending for the force constants and dd, $d\alpha$ and $\alpha\alpha$ indicate bond-bond, bond-angle and angle-angle interactions respectively.

The secular equations for the three types of vibrations are

For A_1

$$\lambda_1 = F_{11}G_{11} = (f_d + 3f_{dd})\,\mu_y \qquad (1)$$

For E

$$\lambda_2 = F_{11}G_{11} = \frac{d^2 (f_\alpha - 2f_{\alpha\alpha})\, 3\mu_y}{d^2} \qquad (2)$$

For F_2

$$\lambda^2 - \lambda \left[f_\alpha \left(2\mu_y + \frac{16}{3}\mu_x\right) - \frac{16\sqrt{2}\mu_x f_{d\alpha}}{3} + \left(f_d - f_{dd}\right)\left(\mu_y + \frac{4}{3}\mu_x\right)\right] + \left[(f_d - f_{dd})\, f_\alpha - 2f_{d\alpha}^2\right] + \left[\left(\mu_y + \frac{4}{3}\mu_x\right)\left(2\mu_y + \frac{16}{3}\mu_x - \frac{64\mu_y^2}{9}\right)\right] \qquad (3)$$

The values of μ used are

$\mu_{O_2} = 3{\cdot}166 \times 10^{-21}$ gm.$^{-1}$
$\mu_o = 3{\cdot}764 \times 10^{-22}$ gm.$^{-1}$

The Raman frequencies in cm.$^{-1}$ of the molecule reported by Woodward and Roberts and their assignments on the basis of polarization characters are given below:

OsO_4	ν_1 (A_1) ..	965	ν_3 (F_2) ..	954
	ν_2 (E) ..	335	ν_4 (F_2) ..	335

By taking into consideration the bond-bond interaction constant the following secular equations are obtained:

$$f_d + 3f_{dd} = 8{\cdot}785 \times 10^5$$
$$9{\cdot}216 f_\alpha - 2{\cdot}408 f_{d\alpha} + 4{\cdot}18\,(f_d - f_{dd}) = 36{\cdot}3 \times 10^5$$
$$(f_d - f_{dd})\, f_\alpha - 2f_{d\alpha}^2 = 3{\cdot}4 \times 10^{10}.$$

Eliminating f_α from the last two equations, the quadratic so obtained in $f_{d\alpha}$ gives two real roots for the values of $(f_d - f_{dd})$ ranging from $0{\cdot}9 \times 10^5$ to $7{\cdot}882 \times 10^5$. The maximum value of $7{\cdot}882 \times 10^5$ has been chosen as it gives the ratio f_{dd}/f_d minimum and the value of f_d so obtained is nearer the value of f_d obtained by the simple valence force field treatment. The force constants thus obtained are listed below and are a unique set, because the quadratic in $f_{d\alpha}$ yields real and coincident values for the particular value of $f_d - f_{dd} = 7{\cdot}882 \times 10^5$.

The force constants in dynes/cm.

f		$f \times 10^{-5}$
f_d	..	8·10750
f_α	..	0·49 00
$f_{d\alpha}$	..	0·51475
f_{dd}	..	0·22575
$f_{\alpha\alpha}$	..	0·14580

Woodward's value for f_d using the valence force field treatment ignoring bond-bond interaction is $8{\cdot}77 \times 10^5$ dynes/cm.

Department of Physics, P. G. PURANIK.
Univ. College of Science, M. L. NARAYANA RAO.
Osmania University;
Department of Mathematics,
Nizam College, Hyderabad-1 (A.P),
August 25, 1958.

1. Woodward, L. A. and Roberts, H. L., *Trans. Farad. Soc.*, 1956, **52**, 615.

THE UNCERTAINTY PRINCIPLE AND RUTHERFORD SCATTERING

In scientific literature we come across many examples of Heisenberg's Principle of Uncertainty which serve to elucidate and provide insight into the fundamental laws of quantum mechanics.* The present note deals with the use of Rutherford Scattering as an "ideal instrument" for the measurement of velocity.

Consider the case of an α-particle scattered through an angle 2θ by the nucleus N (Fig. 1). We have:

$$\tan\theta = \frac{ZeE}{Mv^2} \cdot \frac{1}{b} \qquad (1)$$

where the symbols have their usual meaning. If we measure θ, we can determine the velocity v, by assuming the other quantities as known.

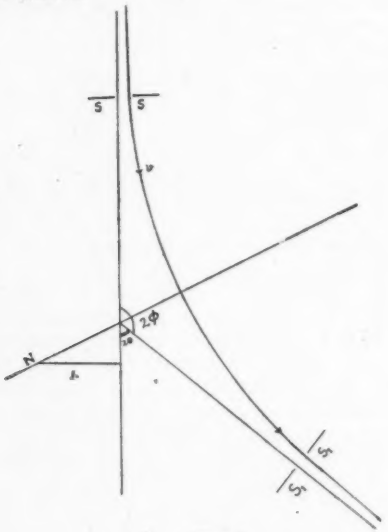


FIG. 1

Writing Mv equal to the momentum p and differentiating, we obtain

$$\frac{\sec^2\theta}{\tan\theta}\,\Delta\phi = \frac{2\,\Delta p}{p}$$

$$\text{or} \quad \frac{\Delta\phi}{\sin 2\theta} = \frac{\Delta p}{p} \qquad (2)$$

If d is the width of the slits SS and S_1S_1 and L the distance between them, the inaccuracy in the measurement of the angle of scattering will be

$$\delta\phi \gtrsim \frac{\lambda}{d} \qquad (3a)$$

where $\lambda = \frac{h}{p}$

and also $$\delta\phi \gtrsim \frac{d}{L} \qquad (3b)$$

The equation (3 a) results from the diffraction of the de Broglie wave in passing through the slit and equation (3 b) expresses the error inherent in the geometry of the experiment. We have then,

$$(\delta\phi)^2 \gtrsim \frac{\lambda}{L} \qquad (4)$$

The uncertainty Δq in the position of the particle along the path SS_1 cannot be less than the product of the uncertainty in its velocity and the time it takes to go through the apparatus, that is

$$\Delta q \gtrsim \frac{\Delta p}{M} \cdot \frac{L}{v} = L\,\frac{\Delta p}{p} \qquad (5)$$

Multiplying (5) by Δp and using (2), we have

$$\Delta q \,.\, \Delta p \gtrsim \frac{L\,(\Delta p)^2}{p} = \frac{(\Delta\phi)^2}{(\sin 2\theta)^2}\,L.p \qquad (6)$$

Inserting the relation (4), we get

$$\Delta q \,.\, \Delta p \gtrsim \frac{\lambda p}{(\sin 2\theta)^2} \gtrsim h$$

as $\sin 2\theta \leqslant 1$

Physics Department, D. V. GOGATE.
Faculty of Science,
M. S. University,
Baroda, *August* 27, 1958.

* Heisenberg, W., *The Physical Principles of Quantum Theory*, Chicago University Press; Darwin, C. G., *Proc. Roy. Soc.*, 1930, **130 A**, 632; Kothari, D. S., *Phil. Mag.*, 1939, **27**, 62.

VARIATION OF HUGGIN'S CONSTANT WITH SOLVENT POWER FOR POLYMETHYL METHACRYLATE SOLUTIONS

The Huggin's equation for the viscosity number can be written as

$$\frac{\eta_{sp}}{c} = [\eta] + k'\,[\eta]^2 c \qquad (1)$$

where η_{sp}/c is the viscosity number, $[\eta]$ is the intrinsic viscosity, c is the concentration and k' is a constant (Huggin's). Recently this constant k' received increasing attention, both theoretically and experimentally. Even though there is some doubt as to the exact significance of the constant, it can be used as a measure of relative effectiveness of various solvents for a given polymer. It was shown by several workers[1–4] that the value of k' varies systematically with the solvent power for the same polymer sample. Eirich and Riseman[2] theoretically predicted a relationship between $[\eta]$ and k' as follows

$$k'\,[\eta]^2 = \alpha + \sigma\,[\eta] \qquad (2)$$

where α and σ are constants. Bhatnagar *et al.*[3] on the basis of the 'theory of rate process' using

an equivalent sphere model arrived at a similar relation. They further showed that

$$a = -\frac{\sigma^2}{2} \qquad (3)$$

There is no sufficient data except that from Strecr and Boyer[4] on polystyrene to verify this equation, because the shear effects will be more for high molecular weight fractions. With the data that are available with us in connection with our work on light scattering and viscosity studies of polymer solutions it is possible to verify the above equation. For a polymethyl methacrylate sample of molecular weight about 404,000 the rate of shear effects will be negligible in a number of solvents. The adsorption effects[6] are also negligible in this concentration range (0·1 to 0·3 gm./100 ml.). Intrinsic viscosities were calculated by drawing η_{sp}/c and $\log \eta_r/c$ against c on the same graph and extrapolating to c = O. It provides a certain check on the extrapolation.

TABLE I

	Solvent	$[\eta]$	$k'[\eta]^2$	k'
1	Chloroform	1·28	0·53	0·337
2	Pyridine	1·20	0·275	0·193
3	Benzene	1·02	0·385	0·371
4	Diethyl ketone	0·745	0·250	0·450
5	Methyl ethyl ketone	0·740	0·250	0·457
6	Acetone	0·708	0·220	0·459
7	Ethyl acetate	0·668	0·210	0·471
8	Normal amyl acetate	0·376	0·070	0·495

The value of k' was determined in eight solvents and the results are shown in Table I. It is clear that the values of k' are increasing with decreasing solvent power, a property which was already established.[1–4] A graph is plotted between $k'[\eta]^2$ and $[\eta]$ as shown in Fig. 1. Except for pyridine all the other points have almost fallen on the straight line. In the case of pyridine the point deviates much from the straight line graph beyond the experimental error.

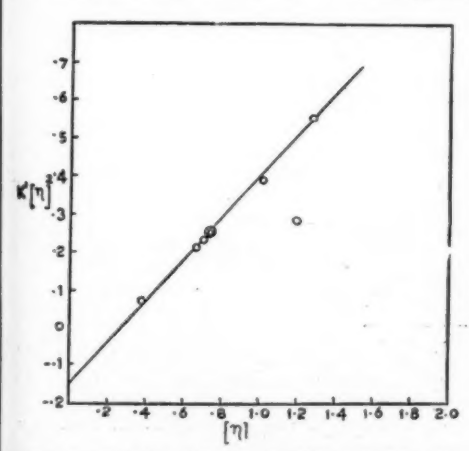


FIG. 1. Relation between k' $[\eta]^2$ and $[\eta]$ for a P.M.M. fraction ($M_v = \cdot 404 \times 10^6$) in various solvents.

The slope and intercept give the values of σ and a. We obtain the value of 0·54 for σ and −0·15 for a. These values also satisfy relation 3.

Department of Physics, Osmania University, Hyderabad-7, *September* 1, 1958.

V. V. VARDAIAH.
V. S. R. RAO.

1. Alfrey, T. (Jr.), Justice, J. D. and Nelson, S., *Trans. Faraday Soc.*, 1946, **42 B**, 50.
2. Eirich, F. and Riseman, J., *J. Polymer Sci.*, 1949, **4**, 417.
3. McGoury, T. E., *M.S. Thesis*, Polytechnic Institute of Brooklyn, 1948.
4. Street, D. J. and Boyer, R. F., *Ind. Eng. Chem.*, 1951, **43**, 1790.
5. Bhatnagar, H. L., Biswas, A. B. and Gharpurey, M. K., *J. Chem. Phys.*, 1958, **28**, 83.
6. Ohm, O. E., *J. Polymer Sci.*, 1953, **17**, 137.

DETERMINATION OF INTERNUCLEAR DISTANCE IN DI-ATOMIC MOLECULES FROM THE INTENSITY OF VIBRATIONAL BANDS

THE intensity of a band belonging to a given electronic transition is proportional to the overlap integral $\int \psi_{v'} \psi_{v''} dr$, to a first approximation, neglecting the variation of electronic transition moment[1]. Numerous methods have been developed for the evaluation of the overlap integral to calculate the relative intensities of vibrational bands belonging to a particular system.

Analytical expressions for the overlap integral which can be conveniently handled are available under Simple Harmonic approximation due to Hutchisson,[2] and Manneback.[3] Similarly in the Morse Oscillator approximation, convenient expressions have been developed by Jarmain and Fraser.[4,5] Both these expressions contain as parameter, $r_e' - r_e''$, where r_e' and r_e'' are the equilibrium internuclear distances for the initial and final states.

While attempting to test the relative merit of the above expressions, by applying them to calculate the relative intensities of vibrational bands of some diatomic molecules appreciable discrepancies were observed. Thus, using Hutchisson's and Manneback's method, it was found that for certain system of bands for

instance Na_2 ultraviolet bands $c'\Sigma_u^+ \leftrightarrow X'\Sigma_g^+$ – the calculated intensity distribution was widely different from the observed ones. It became easily discernible that the calculated intensity distribution pattern was highly sensitive to the value of $r_e' - r_e''$ — (this difference will be denoted by Δr_e in this paper)—and if one of these quantities was not accurately known the theoretical intensity pattern will be altogether different from the observed one. On investigation the Fraser and Jarmain expression for the overlap integral was also found to be quite sensitive (although not to the same extent) to variation in Δr_e. It is found that for small variation in Δr_e the calculated relative intensity shows linear variation.

Impressed by the sensitiveness of these expressions to Δr_e values it was considered worthwhile to reverse the process and to use the precise microphotometrically measured intensity data for an accurate calculation of Δr_e. In that case if one of the two quantities, r_e' or r_e'' is known from rotational analysis or from X-ray or Electron diffraction work, then the other can be calculated without going in for rotational analysis.

To test the possibility of the above method, three well established band systems were selected :—CN violet $B^2\Sigma \rightarrow X^2\Sigma$ system; N_2 second positive $C^3\pi \rightarrow B^3\pi$ system and C_2 Swan $A^3\pi \rightarrow X^3\pi$ system. Experimental intensity data as well as r_e values in both the states are accurately known for these systems. First of all a provisional value of Δr_e is obtained using the ratio of intensities of (0, 0) and (0, 1) bands and Manneback expression for p (0, 0)/p (0, 1). The actual value of Δr_e will lie close to it. A set of values for Δr_e differing by small amounts were then selected and the intensities of all the bands whose v' and $v'' \leqslant 2$ were calculated relative to (0, 0) band, using Fraser and Jarmain method. From these values the ratios p (0, 1)/p (0, 0) ; p (0, 2)/p (0, 0) ; p (1, 1)/p (1, 0), etc., were found out for each value of Δr_e and a graph (relative intensity *vs.* Δr_e) was drawn for each case. From these graphs the value of Δr_e corresponding to the experimentally observed value of intensity was read out.

The value of Δr_e thus obtained for the above band systems showed small scatter about the mean value which in all cases agreed with the accepted value to a fairly high degree of accuracy.

The results are shown below.

C_2 Swan		N_2 Second positive		CN violet	
Bands whose intensities were compared	Estimated $r_e' - r_e''$	Bands whose intensities were compared	Estimated $r_e' - r_e''$	Bands whose intensities were compared	Estimated $r_e' - r_e''$
(2, 0), (2, 2)	0·0441	(2, 0), (2, 1)	0·0614	(0, 1), (0, 0)	0·0218
(2, 2), (2, 1)	0·0430	(1, 2), (1, 0)	0·0688	(1, 0), (1, 2)	0·0231
(2, 0), (2, 1)	0·0474	(2, 2), (2, 1)	0·0616	(1, 0), (1, 1)	0·0202
(1, 0), (1, 2)	0·0495	(2, 2), (2, 0)	0·0636	(1, 2), (1, 1)	0·0197
(1, 1), (1, 2)	0·0493	(1, 2), (1, 1)	0·0598	(2, 1), (2, 2)	0·0202
(1, 0), (1, 1)	0·0450	(0, 2), (0, 0)	0·0657		
(0, 2), (0, 0)	0·0410	(1, 1), (1, 0)	0·0623	Average ..	0·0210
(0, 1), (0, 0)	0·0393	(0, 1), (0, 0)	0·0646		
		(0, 2), (0, 1)	0·0668	Accepted value *	0·0212
Average ..	0·0437				
		Average ..	0·0638		
Accepted value *	0·0457				
		Accepted value *	0·0641		

* Accepted values are from Herzberg.[1]

The above method thus provides a new and accurate method, not involving rotational analysis for the determination of r_e value for an electronic state of a molecule provided this state combines with another electronic state of known r_e value.

Department of Physics, S. P. SINHA.
L. S. College (Bihar University), S. S. PRASAD.
Muzaffarpur (Bihar),
August 21, 1958.

1. Herzberg, G., *Spectra of Di-Atomic Molecules*, Second Edition, 1950, 200.
2. Hutchisson, E., *Phys. Rev.*, 1950, **36**, 410.
3. Manneback, C., *Physica*, 1951, **17**, 1001.
4. Fraser, P. A. and Jarmain, W. R., *Proc. Phys. Soc.*, 1953, **66 A**, 1145.
5. —., *Ibid.*, 1953, **66 A**, 1153.

ANODIC OXIDATION OF MANGANOUS SULPHATE IN AQUEOUS SULPHURIC ACID

WHILE investigating the various electrochemical factors involved in the anodic oxidation of toluene to benzaldehyde, it was observed that the yield of benzaldehyde depends upon the formation of manganic sulphate from manganous sulphate which has been used as an "oxygen carrier". It was thus considered worthwhile investigating the optimum conditions for the formation of manganic sulphate in aqueous sulphuric acid using lead anode.

Extensive investigations have been carried out by earlier workers on the electrolytic oxidation of manganous sulphate.[1–4] These have been done mostly with platinum anodes. Lang,[2] however, employed a lead-lined cell, the cell itself being used as anode. These investigators all employed only clear solutions of manganous sulphate in sulphuric acid. Solanki *et al.*[3] reported about 70% current efficiency. In the present work two sets of experiments were done, one using a clear solution of 28 g. of manganous sulphate in 700 c.c. of 55% sulphuric acid, and the second using a suspension of 200 g. of exsiccated manganous sulphate[5] in 700 c.c. of 55% sulphuric acid. The experiments were carried out in a cylindrical glass beaker. Two lead cathodes, each $5 \times 17{\cdot}4$ mm. were employed on either side of a cylindrical lead anode with an effective area of 1·2 sq. dm. The electroyte was agitated by an electrical stirrer, when the anode used was stationary.

The current efficiency was determined after electrolysis, by adding a definite volume of the electrolyte or a known weight of the paste, to a known excess of ferrous sulphate solution and titrating the excess of ferrous ion against standard permanganate. The current efficiency was found to be 75% with a stationary anode. Rotating the anode increased the current efficiency slightly, but changing the interelectrode distance did not influence the same. Anodes of lead, antimonial lead and lead dioxide, all gave the same satisfactory results. Anode potentials above 1·8 volts (hydrogen scale) diminished current efficiency. Separating the anode chamber from the cathodes did not affect current efficiency appreciably, indicating that trivalent manganese is not cathodically reduced, much under the experimental conditions employed. In the case of suspended manganous sulphate, it was possible to convert the whole of it, by passing enough current, into a paste of manganic sulphate.

Fuller details of the investigation will be published elsewhere.

The authors express their sincere thanks to Dr. K. S. G. Doss, Director of the Institute for his keen interest in the investigation.

M. S. VENKATACHALAPATHY.
R. RAMASWAMY.
H. V. K. UDUPA.

Central Electrochemical
Research Institute.
Karaikudi,
August 29, 1958.

1. Mellor, J. W., *A Comprehensive Treatise on Inorganic and Theoretical Chemistry*, Longmans Green & Co., London, 1932, **12**, 431.
2. Lang, W., German Patent, D. R. P., 1906, 166, 357; 1908, 189, 178.
3. Solanki *et al.*, *J. Ind. Chem. Soc.*, 1942, **19**, 473–80.
4. Gorbachev, S. V., *et al.*, *J. Gen. Chem.* (*U.S.S.R.*), 1940, **10**, 1961–67.
5. Indian Patent (Filed, 1957), No. 62379.

ION-EXCHANGE SEPARATION OF LIGHT RARE EARTHS USING SODIUM TRIPOLYPHOSPHATE

WELL KNOWN eluants used in the ion-exchange separation of rare earths by complexing elution are organic complexing agents[1–7] such as citric, tartaric, lactic, nitrilo-triacetic and ethylenediamine-tetraacetic acids. The condensed alkali phosphates, which form an important class of inorganic sequestering agents, do not appear to have been much studied for these separations. The feasibility of using sodium tripolyphosphate as eluting agent for the purpose is under investigation in this Laboratory.

Preliminary experiments on the distribution of the rare earth tripolyphosphate complexes between the solution phase and a strongly basic anion exchanger, Amberlite IRA 400, have indicated that these complexes are anionic and stable in the pH range 2-10.

Elution with 0·3-0·5% w/v sodium tripolyphosphate solution of a mixture of La^{+++}, Pr^{+++}, Nd^{+++} and Sm^{+++} adsorbed in a narrow band on the top of a cation exchanger (Dowex 50) column has given us varying degrees of fractionation depending upon the pH and concentration of the eluant. Particulars of one typical elution experiment are given below:

A rare earth mixture (20% La_2O_3, 13% Pr_2O_3, 59% Nd_2O_3, 8% Sm_2O_3, total load 940 mg. oxide) was taken on the top of a Dowex 50 resin bed (2 cm. dia. × 110 cm. long) by batchwise equilibration. Elution was started with a 0·3% solution of sodium tripolyphosphate (w/v), which was increased to 0·5% after the first two

litres. The pH of the eluant was 3·6 for both solutions. Analyses of the starting mixture and the effluent fractions were done spectrophotometrically. The elution curve is given in Fig. 1.

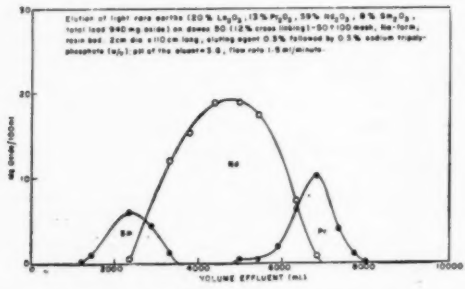


FIG. 1

The absence of lanthanum in the elution curve (Fig. 1) is due to the fact that lanthanum is retained on the exchanger.

Details of this investigation will be published shortly.

National Chemical Lab., Poona-8,
September 18, 1958.

P. R. SUBBARAMAN.
K. S. RAJAN.
J. GUPTA.

1. Spedding, F. H., Voigt, A. F., Gladrow, E. M. and Sleight, N. R., *J. Am. Chem. Soc.*, 1947. **69**, 2777.
2. — and Powell, J. E., *Ibid.*, 1954. **76**, 2550.
3. Vickery, R. C., *J. Chem. Soc.*, 1952, 4357.
4. Mayer, S. W. and Freiling, E. L., *J. Am. Chem. Soc.*, 1953, **75**, 5647.
5. Fitch, F. T and Russel, D. S., *Canad. J. Chem.* 1951, **29**, 363.
6. Spedding, F.H., Powell, J. E. and Wheelwright, E.J., *J. Am. Chem. Soc.*, 1954, **76**, 612.
7. —, *Ibid.*, 1954, **76**, 2557.

SOME PHARMACOLOGICAL ACTIONS OF EVOLVINE HYDROCHLORIDE

IN a previous communication,[1] it was reported that a basic liquid substance, isolated from *Evolvulus aslsinoides* (Vishnugrandhi), exhibited lobeline-like action on cardiovascular and respiratory systems. Attempts at further purification, resulted in the isolation of a crystalline hydrochloride, named provisionally Evolvine hydrochloride ($C_{12}H_{17}NO_2$ HCl, M.P. 216°). With the amount of this substance made available, a few pharmacological actions were studied to elicit if this exhibited properties similar to the liquid material.

Materials and Methods.—Cats weighing between 2-4 kg. were used. After preliminary æther, anæsthesia was maintained with chloralose administered intravenously (80 mg./kg. as a 1% solution). In some experiments dogs weighing between 5-10 kg. were used, anæsthetised with chloralose, in the same dose range, without preliminary æther.

Blood pressure was recorded from a carotid artery. Trachea was cannulated and respirations recorded by a Mary's tambour. A femoral vein was cannulated for injection of drugs. Spleen volume was recorded by enclosing the spleen in an oncometer, and connected to a sensitive tambour. The peripheral pressure was recorded from a femoral artery by Rawolf's method. Studies on isolated tissues were carried out using one born of rat's uterus, and a small piece of rat's ileum about 2 cm. in length, suspended in oxygenated Dale and Tyrode solutions respectively, in a 50 ml. bath, maintained at a constant temperature (37° C.)

Dosage Schedule.—The drug was used in doses of 1 mg. and 2 mg./1 kg. body weight, for systemic administration. A dose of 1 mg. was added to the bath, for effects on isolated tissues, and the same dose was used for injection into the peripheral circulation. During preliminary tests, the substance exhibited sympathomimetic activity. Hence Adrenaline in doses of 0·1 ml. to 0·2 ml. of a 1 : 10,000 solution was used wherever necessary for comparison. Sufficient time (from 15-30 minutes) was allowed between doses, for the responses to recover to preinjection levels.

Results.—The effects on blood pressure, spleen volume, and respiration, of a 1 mg./kg. dose of Evolvine hydrochloride compared to 0·1 ml. of 1 : 10,000, Adrenaline are seen in Fig. 1. They closely resemble each other, except that the blood pressure remained elevated for a longer duration, compared to adrenaline. The effects on respiration by Evolvine were neither sustained nor lobeline like.

The intensity of response was not proportionate when the dose was raised to 2 mg./kg. (Fig. 2). Neither repetition of the same dose nor an increase in the dose range was found to improve the responses.

An increase in peripheral pressure was noticed, when the drug was injected locally, as well as into general circulation (in suitable doses) indicating peripheral vaso constriction (Fig. 3).

Intracarotid injection of the drug (1 mg.) produced a rise in blood pressure, which was sustained for an appreciable time. Effects on respiration were not significant (Fig. 4).

Isolated Tissues.—Uterus : Significant relaxation, and later on a decrease in frequency, and height of contractions were noticed, with 1 mg. of Evolvine added to the bath (Fig 5).

Next, contraction was induced by adding 1 unit of oxytocin to the bath. When it was at its maximum the bath was quickly changed and 1 mg. of the drug was added. Again relaxation was evident (Fig 6).

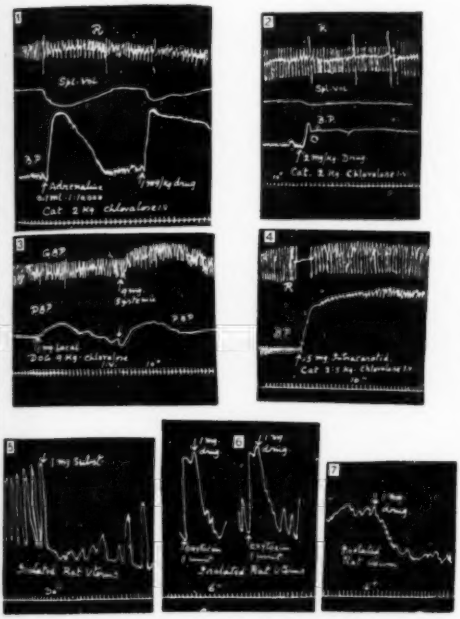


FIG. 1. Cat 2 kg. Chloralose Anæsthesia. Record from above downwards: Respiration, spleen volume, blood pressure and time marking 10".

At first arrow: Adrenaline 0·1 ml. of 1 : 10,000 I.V. At second arrow: 1 mg./kg. of Evolvine hydrochloride I.V. Note the similarity in effects. B.P. after the drug tends to remain elevated.

FIG. 2. At arrow 2 mg./kg. of Evolvine administered I.V. Note: No increase in response noticed.

FIG. 3. Dog 9 kg. Chloralose. Upper tracing. Systemic B.P. Lower: Peripheral blood pressure. Arrow at lower tracing: 1 mg. of the drug locally: A rise in peripheral pressure was seen. Arrow at the upper tracing: 9 mg./kg. I.V: The rise in peripheral pressure was prominent.

FIG. 4. At arrow 0·5 mg. of Evolvine intracarotid. Note: The prompt sustained rise in B.P. No significant effect on respiration.

FIG. 5. Isolated Rat Uterus: Relaxation on addition of 1 mg. of the drug at arrow to the bath.

FIG. 6. Isolated Rat Uterus: At lower arrow: 1 unit of oxitocin. At upper arrows: 1 mg. of drug after changing the bath. Note the relaxation.

FIG 7. Isolated Rat's Ileum: At arrow 1 mg. of drug added to bath. Note: Significant relaxation. Movements not completely abolished.

Ileum.—Decrease in tone, without complete abolition of fine movements, was noticed (Fig. 7).

The data so far obtained indicate that Evolvine hydrochloride has a sympathomimetic action. The effects on blood pressure are more sustained compared to Adrenaline, though the dose of Evolvine required to produce an equal effect is high: Tachyphylaxis is a feature of the drug. Peripheral and splanchnic vaso constriction seem to contribute a large measure, in bringing about a rise in blood pressure. The elevation in blood pressure, seen following intracarotid injection, indicates a central action in addition, probably mediated through the carotid sinus mechanisms. However, all the three factors seem to contribute to the effects noticed. Evolvine has not exhibited significant effects on respiration, compared to the stimulant action noticed with the liquid material previously. This action might have been due to some fraction contained in the liquid material and absent in the purified substance.

Evolvine hydrochloride seems to mimic adrenaline in some respects and Ephedrine in others. Further elucidation is required to come to any conclusion. This will be taken up when more of the drug is available.

Summary.—Evolving hydrochloride possesses sympathomimitic properties. For its inclusion, as a useful member of sympathomimitic family of drugs, further investigation is necessary.

I am grateful to Mr. M. V. Rama Rao, and Mr. T. S. Vaidyanathan of the Pharmaceutics Department, Madras Medical College, for making the substance available.

T. R. KRISHNAMURTHY.

Pharmacology Laboratory,
Stanley Medical College,
Madras,
September 23, 1958.

1. Guruswamy, M. N., Krishnamurthy, T. R. and Vaidyanathan, T. S., *Curr. Sci.*, April 1956, **25**, 119–20.

TETRACYCLINES

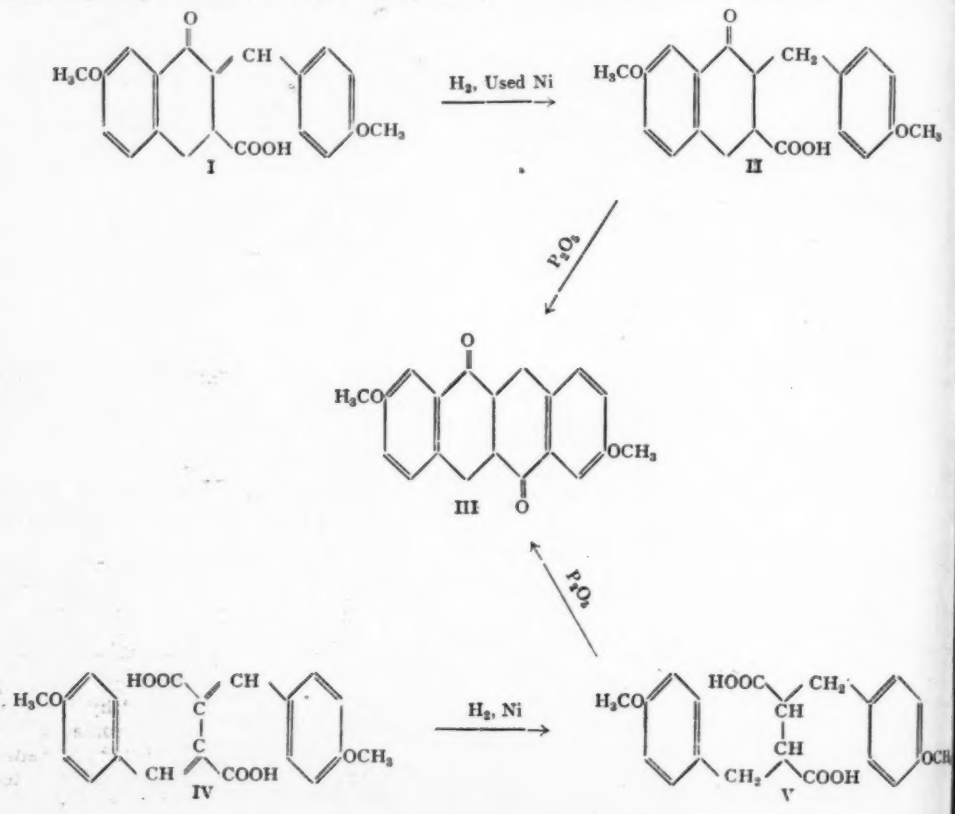
Part II. Synthesis of 2, 8-Dimethoxy-5, 5 a, 6, 11, 11 a, 12-Hexahydronaphthacene-6, 12-Dione

IN a recent communication,[1] the synthesis of 7, 10-dimethoxy-5, 6, 11, 12-tetrahydronaphthacene-6, 12-dione was reported. The low yield of the hydronaphthacene in the last step, *viz.*, cyclisation of the *o*-carboxy benzylidene tetralone, as well as the difficulty of preparing appropriately substituted phthalaldehydic acids, prompted us to search for other routes which would lead to the desired compounds in better overall yield from more easily accessible materials. The present paper outlines one such route.

7-Methoxy-3-carboxytetralone[2] was condensed with anisaldehyde in the presence of alkali to give 7-methoxy-3-carboxy-2-anisylidenetetralone (1); crystallised from dilute acetic acid, m.p. 180-81°. (Found: C, 71·1; H, 5·2% $C_{20}H_{18}O_5$ requires C, 71·0; H, 5·3%.) Attempts to cyclise (I) to the corresponding hydronaphthacene using polyphosphoric acid or phosphorus pentoxide in boiling benzene gave very small quantities of a highly coloured material which could not be isolated in a crystalline form. Reduction of (I) in alkaline solution by hydrogen in the presence of used Raney nickel gave 7-methoxy-3-carboxy-2-anisyl-tetralone (II); crystallised from ethyl acetate-petroleum ether (40-60°), m.p. 163-65°. (Found: C, 70·8; H, 5·6%; $C_{20}H_{20}O_5$ requires C, 70·5; H, 5·9%.)

Cyclisation of (II) by phosphorus pentoxide in boiling benzene gave 2, 8-dimethoxy-5, 5a, 6, 11, 11a, 12-hexahydronaphthacene-6, 12-dione (III) in good yield; crystallised from benzene, m.p. 238-40°. Found: C, 74·3; H, 6·0%; $C_{20}H_{18}O_4$ requires C, 74·5; H, 5·6% bis-2, 4-dinitrophenylhydrazone crystallised from nitrobenzene, m.p. 308° (dec.). (Found C, 56·4; H, 3·9; N, 16·4%; $C_{32}H_{26}N_8O_{10}$ requires C, 56·4; H, 3·7, N, 16·4%.)

Weizmann[3] described the synthesis of 5, 5a, 11, 11a, 12-hexahydronaphthacene-6, 12-dione by the cyclisation of dibenzyl succinic acid. It was found possible to synthesise (III) by the same route and confirm its structure. Dianisylidene succinic acid[4] (IV) was reduced in alkaline solution by hydrogen in the presence of Raney nickel to give dianisyl succinic acid (V), crystallised from acetic acid, m.p. 200-201° (Found: C, 67·2; H, 6·2% ; $C_{20}H_2.O_6$ requires C, 67·0; H, 6·1%.) The dicarboxylic acid (V) was cyclised by phosphorus pentoxide in boiling benzene to give a dione, and that it is (III) was confirmed by the melting point and mixed melting point determinations. The yield of (III) by the latter method was, however, very poor



Further work is in progress employing substituted tetralone carboxylic acids and aromatic aldehydes.

Chemistry Department, Institute of Science, Bombay-1,
S. Seshadri.
A. B. Kulkarni.

August 16, 1958.

1. Pandit, A. L., and Kulkarni, A. B., *Curr. Sci.*, 1958, **27**, 254. (This is considered as Part I in this series.)
2. Campbell, K. N. and Co-workers, *J. Amer. Chem. Soc.*, 1953, **75**, 4681.
3. Weizmann, A., *J. Org. Chem.*, 1943, **8**, 285.
4. Baddar, F. G. and Co-workers, *J. Chem. Soc.*, 1948, 1270.

SILICON TETRACHLORIDE, A NEW CONDENSING AGENT FOR PECHMANN REACTION

Out of several methods for synthesizing coumarins,[1] the Pechmann reaction,[2] consisting of condensation of a phenol with a β-ketonic ester, is considered to be the most convenient. In this reaction, the choice of a proper condensing agent plays a very important part. Sulphuric acid, phosphorous pentoxide, phosphorous oxychloride, anhydrous aluminium chloride and zinc chloride have been employed extensively to bring about the condensation.

In a search for a new condensing agent, it has been found that silicon tetrachloride serves as a good condensing agent for the condensation of the more reactive phenols with β-ketonic ester. Resorcinol and phloroglucinol condensed with ethyl acetoacetate in presence of silicon tetrachloride to give the corresponding coumarin derivatives. But, it failed to bring about the condensation in case of the less reactive phenols, such as phenol and methyl-β-resorcylate. The experimental procedure is as follows:

Silicon tetrachloride (25 ml.) was added to a solution of resorcinol (5·5 g.) in ethyl acetoacetate (6·5 g.) with constant shaking. The reaction mixture was refluxed on water-bath for 4 hours with a calcium chloride guard tube. It was then poured into ice and water. The product with silica was collected on the filter and washed several times with water. The crude product was dissolved in a minimum quantity of alcohol and filtered to remove silica. It was finally crystallized from aqueous alcohol; yield 2·5 g., m.p. and mixed m.p. with an authentic sample of 7-hydroxy-4-methylcoumarin[3] was 185° C.

I am thankful to Professor Suresh M. Sethna for suggesting the problem and also for guidance and help.

Chemistry Department, Faculty of Science, M.S. University of Baroda, Baroda-2,
K. N. Trivedi.

September 22, 1958.

1. Sethna and Shah, *Chem. revs.*, 1945, **36**, 1.
2. — and Phalake, *Organic Reactions*, 1953, **7**, 1.
3. Pechmann and Duisberg, *Ber.*, 1883, **16**, 2119.

SOME OBSERVATIONS ON A RICE DISEASE

In 1955 complaints of an unknown disease of rice were received from some cultivators of Telengana. The trouble was found to be more serious in poorly drained soils and where high doses of ammonium sulphate were applied. The disease has been observed to occur in patches and usually appeared 4 to 6 weeks after transplanting (Fig. 1). The tips of leaves of the

Fig. 1. Rice field affected by sulphide injury.

affected crop dried up and assumed a brownish colour which in early stages resembled the symptoms of attack by *Curvularia lunata*. The affected leaves dried up prematurely and sometimes the entire plant died. It was found to be more serious during Rabi season (December-April), when the water-supply was not adequate, specially in areas where rice cultivation was done under lift irrigation.

The soil in the affected fields appeared dark and formed almost a crust on the surface. The roots of the affected plants appeared shining black instead of the normal whitish-brown colour and emitted sulphide odour. When they were washed in clean or running water and exposed to the atmosphere, the normal colour of the roots reappeared within 20 to 30 minutes. When the affected roots were placed in dilute hydrochloric acid, hydrogen sulphide was evolved. The black coating on the roots was

probably ferrous sulphide, which inhibited the absorption of food materials, causing the death of the plant.

The following methods have been found helpful in checking the harmful effects of sulphide injury:

(1) Flooding the fields and thoroughly stirring the soil either by hand or by a weeder, depending upon the cultural practices. Draining the fields until slight surface cracks appear and then letting in water. Repeating this alternate wetting and drying once or twice till the crop recovers. (2) Opening shallow drains around the fields to increase drainage. (3) Discouraging use of fertilizers containing sulphates in poorly drained soils. (4) As far as possible, not allowing drained water to pass through other fields.

Help of T. Seshagiri Rao is gratefully acknowledged.

Directorate of Plant Protection, Quarantine and Storage, New Delhi, *July* 15, 1958.

D. BAP REDDY.

[*Hydrogen sulphide in waterlogged soils is formed mainly by reduction of sulphate, for which the cellulose—butyric acid fermentation provides the hydrogen source. Use of ammonium nitrate mixed with powdered lime in the field was found to be effective in controlling the sulphide injuries. The atomic hydrogen, formed by butyric acid fermentation, is used to reduce nitrate, and consequently the sulphate reduction is prevented. R. Vamos* in Nature, *Dec.* 13, 1958, p. 1688.—*Ed.*]

OCCURRENCE OF MONAZITE IN CHARNOCKITES

ALMOST immediately after monazite was noticed in the beach sands of Visakhapatnam coast by Mahadevan and Sriramadas,[1] its source was ascribed to the neighbouring pegmatites.[2] In a recent issue of this journal, Murty[3] has reported the occurrence of monazite in the charnockites of the Visakhapatnam area.

The recognition of monazite not only in the pegmatites but in the charnockites and leptynites of the Visakhapatnam area brings this into line with similar occurrences in Travancore. Tipper[4] in 1914 believed that the gneissic rocks of South Travancore provided the source for this mineral. In 1921, Chacko[5] stated that the pegmatites and the leptynitic gneisses of this region were the primary sources of the monazite sands.

In 1953, the present writer[6] stated that the monazite beach sands of Travancore were in part derived from the charnockites. It was Paulose,[7] however, who recently provided accurate information on the rocks of South Travancore which contain monazite. By microscopic examination and heavy mineral analysis he showed that the leptynites and acid charnockites were monazite-bearing, whereas intermediate and basic charnockites were devoid of this mineral. In the Visakhapatnam area also the basic charnockites do not contain monazite whereas acid and intermediate charnockites are monazites-bearing, the former being richer in the mineral than the latter.

I have examined many thin sections of Travancore charnockites and leptynites which contain this mineral, and have been struck by the smooth rounded or oval outlines of the monazite grains occurring in them. In fact, a concentrate of this mineral obtained from these rocks is practically indistinguishable from the rounded grains found at present in the beach sands. The characteristically anhedral and rounded or oval nature of this mineral has been noticed not only in South Travancore,[8] but now in the Visakhapatnam area[9] also.

Monazites occurring in the pegmatites near Bangalore have well-developed crystal faces. I have not examined the monazite-bearing pegmatites of South Travancore or the Visakhapatnam areas, but it is to be expected that the mineral would be somewhat euhedral.

Leptynites have generally been considered as metamorphosed sediments, and the rounded or oval nature of small monazite grains in them is, therefore, not difficult to explain. The occurrence of such rounded grains in charnockites, however, is intriguing. It may well be that the monazite-bearing 'acid' charnockites were also originally sediments which contained detrital grains of this mineral.

Department of Geology, University of Malaya, Singapore, *October* 12, 1958.

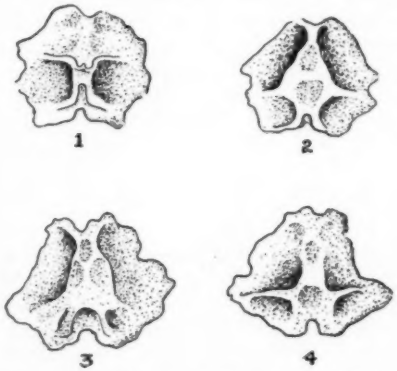
C. S. PICHAMUTHU.

1. Mahadevan, C. and Sriramadas, A., "Monazite in the beach sands of Vizagapatnam District," *Proc. Ind. Acad. Sci.*, 1948, **27 A**, 275–78.
2. — and Sathapathi, N., *Curr. Sci.*, 1948, **17**, 297.
3. Murty, M. S., "Occurrence of monazite in the charnockites of Visakhapatnam," *Ibid.*, 1958, **27**, 347–48.
4. Tipper, G. H., "The monazite sands of Travancore," *Rec. Geol. Surv. Ind.*, 1914, **44**, 186–95.
5. Chacko, I. C., "A sketch of the geology of Travancore," *Rec. Dept. Geol. Trav.*, 1921, **1**, 39–40.
6. Pichamuthu, C. S., *The Charnockite Problem*, Mys. Geol. Assn. Special Publication, 1953, **46**.
7. Paulose, C. V., "Charnockites and associated rocks of the Cape Comorin Area, S. India," *Bull. Mys. Geol. Assn.*, 1956, No. 9.
8. —, *Ibid.*, 22, 25, 61.
9. Murty, M. S., *loc. cit.*, 347–48.

OCCURRENCE OF OPHIUROID OSSICLES IN THE MIOCENE OF KATHIAWAR, WESTERN INDIA

THE object of this paper is to place on record the discovery of abundant ophiuroid ossicles (arm bones) in the Miocene (Burdigalian) beds of Kathiawar, Western India. Although the ophiuroids are plentiful in the present-day seas, their fossil records have been scanty. This is due chiefly to the fragile structure of the organisms themselves. Complete specimens are rarely found as fossils, though individual specimens of the arm bones are fairly common in some Tertiary sediments. This paper reports first known occurrence of Tertiary ophiurans from India.

The material on which the present paper is based was collected by Dr. Krishna Mohan (now working at the State Museum, University of Neberaska), during the field seasons 1952, 1953, 1954, and subsequently handed over to the author for a detailed study of the microfossil contents. The specimens of ophiuroid ossicles were obtained from sample 'H' (*vide* Mohan and Chatterji[3]) from the *'Orbiculina'* limestone exposed 1½ miles N. 34° E. of Bhogat village (21° 59' N. : 69° 14' E.). A few of these arm bones are illustrated here (Figs. 1-4).



FIGS 1–4. Arm bones of Miocene ophiuroids from Kathiawar. All figures, × 35. Figs. 1 and 3, outer face; Figs. 2 and 4, inner face.

A majority of these specimens were recovered from washings retained on the 40-mesh sieves.

The stratigraphical significance of the ophiuran arm bones was first stressed by Howe,[2] in his paper 'Neglected Gulf Coast Tertiary Microfossils'. The ecological significance of recent ophiuroids was discussed by Lyman,[4] who noted that the majority of the species lived in a zone lying between the low-tide mark and 180 feet. Of the various genera reported by him, sixteen do not go lower than 30 fathoms and are usually common in warm waters.

The presence of ophiuran arm bones in the Miocene of Kathiawar, therefore, appears to be of some ecological significance. Bhatia and Mohan[1] studied in detail the palæoecology of the Kathiawar Miocene, and, on the evidence furnished by the foraminiferal fauna, concluded that the *'Orbiculina'* beds, together with the Visawara limestone, were deposited in a shallow infra-neritic sea, at depths between 20 and 100 fathoms. These conclusions are further corroborated by the presence in these beds of large number of ophiuran arm bones.

In the absence of any schematic classification of ophiuran arm bones and also due to the lack of preservation of mouth parts, no specific identification is possible at present. However, the present study indicates that these arm bones belong to Lyman's family Ophiuridæ. Detailed work on these is in progress, and the results will be published shortly.

The author wishes to thank Dr. Krishna Mohan for the loan of the material and also for permitting him to publish this paper.

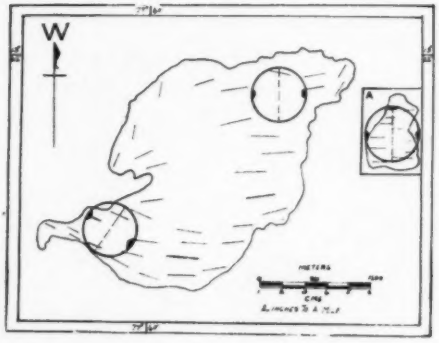
Department of Geology, S. B. BHATIA.
University of Lucknow,
Lucknow,
September 4, 1958.

1. Bhatia, S. B. and Mohan, K., "Miocene (Burdigalian) Foraminifera from Kathiawar, Western India," *Jour. Palcont.* (in press).
2. Howe, H. V., "Neglected Gulf Coast Tertiary Microfossils," *Bull. Amer. Assoc. Petr. Geol.*, 1942, **26**, 1188-99.
3. Mohan, K. and Chatterji, A. K., "Stratigraphy of the Miocene beds of Kathiawar, Western India," *Micropalæontology*, 1956, **2**, 349–56.
4. Lyman, T., *Report on the Ophiuroidea Dredged by H.M.S. Challenger*, **1873-76**; *Rept. Sci. Res. Voiage H.M.S. Challenger, Zool.*, 1882, **5**, 386.

A NOTE ON THE JOINT PATTERN IN NANDI GRANITES

IT has been admirably demonstrated by Cloos[2] (1937) and Balk[3] (1948) that joints in granites are very suggestive of their mode of emplacement. It may be stated that this line of approach is still in its infant stage in Mysore, despite the availability of quite a large number of granite bodies. The only contribution in this direction is by Srinivasa Rao[4] (1956) on Chamundi granites. Similar lines of investigations have been undertaken by the writer on the Nandi granites and an attempt is made in this note to present the results of the preliminary study.

The granite body under study crops out as an elongated lenticular mass, situated in Kolar District, Mysore State. The rocks are generally a series of grey coarse to fine grained gneissic granites, ranging in composition from granites to granodiorites. In the field the out-crop grades into a series of gneissic rocks, containing a number of autoliths. Further outwards, in the country rocks, basic xenoliths of various sizes are seen arranged in an en-echelon manner. Just along the borders of the out-crop there are numerous 'schlieren' patches forming quite a conspicuous feature. In the present study the orientation of the joints in the field has been obtained with reference to the foliation directions, seen in the rocks. This helps to fix up the nature of joints. Without this they are not absolute and no definite orientation of the joints could be ascertained.



Map 1

Generalized Foliation Direction in Nandi Granites.

(Inset A) Isolated out-crop to the east of the main granitic body. (Inscribed circles indicate the orientation of "Q" joints.)

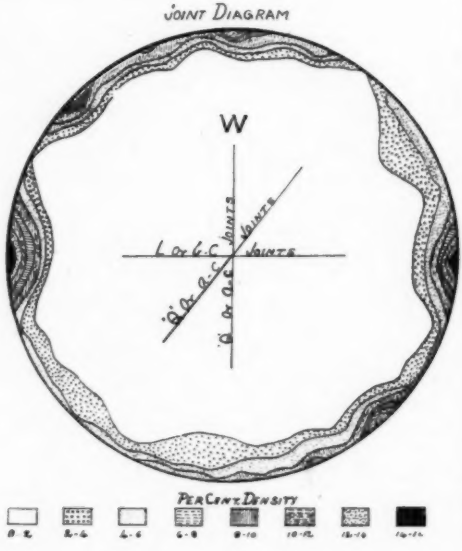
About hundred compass readings of joints obtained all over the exposed portions of the out-crop were projected on to a 2" to 1 mile map. Further the poles of the joint planes were plotted on Schmidt equal-area projection and a contour diagram was prepared (Billings).[1]

An examination of the map and joint diagram shows that there are at least two prominent sets of joints.

(1) Parallel to foliation direction (Longitudinal joints).

(2) Perpendicular to foliation direction (Cross-joints).

In conventional terms the former is called the 'L' or *b-c* joints and the latter is called the 'Q' or *a-c* joints. Further it is interesting to note that the 'Q' joints show two maxima on the point diagram, i.e., 16 to 14% density, and 14 to 12% density, separated by an angle of 20 to 30°. Besides the above types of joints, there are also a few random diagonal joints or 'D' joints. The general trends of the foliation direction, shown in map, are also in agreement with the two maxima of the 'Q' joints. Further it is seen from the diagram that the most prominent jointing direction is North-South varying to NNE. Next to this is the East-West jointing direction, with a few irregularly arranged joints.



Contour diagram of 100 joints plotted on Schmidt equal-area projection

At this stage of investigation, it is very difficult to ascertain the exact mode of emplacement of these granite bodies. But a suggestion could be made, as far as the present study discloses, that foliations in these granites are the result of movements in late fluid stage and joints are the products of solidification and continuous movements at late solid stage resulting in ruptures and fractures. Further work in this respect is in progress.

The writer wishes to express sincere thanks to Prof. M. R. Srinivasa Rao for suggestions and guidance throughout the preparation of this note. Grateful acknowledgement is made to

Dr. C. Gundu Rao for critical reading of the manuscript.

Department of Geology, A. ACHUTHA RAO.
University of Mysore,
Central College, Bangalore,
October 3, 1958.

1. Billings, M. P., *Structural Geology*, 1956.
2. Cloos, E., *Maryland Geological Survey Report*, 1937, **13.**
3. Robert Balk, *Structural Behaviour of Igneous Rocks*, 1948.
4. Srinivasa Rao, M. R., "Structure and Petro-chemistry of the Chamundi Granites, Mysore State," *Bull. Mys. Geol. Assoc.*, No. 11.

CATION EXCHANGE CAPACITY OF PLANT ROOTS

ALTHOUGH Devaux[1] reported the existence of cation exchange properties of roots as early as 1916, the importance of this phenomenon has not been recognised till recently. Arnon *et al.*[2] showed that plants actually lost metal cations to culture solutions at pH 3. Ramamoorthy and Desai[3] reported that manganese is exchanged for iron by the tobacco leaf during the recovery of a manganese induced iron deficiency and chlorosis. It remained, however, for Williams and Coleman[4] and Drake *et al.*[5] to show experimentally that plants have cation exchange capacities of considerable magnitude. This capacity has also been shown to be important in determining the compatability of plants under mixed cropping[6] and the ratio of the uptake of monovalent to divalent cations by plants.

Schuffelen and Middelburg have proposed a rapid method for the determination of cation exchange capacity of plant roots suitable for routine work in which mature roots after being dried and ground were leached with dilute acid, saturated with calcium by leaching with calcium acetate solution and the cation exchange capacity (C.E.C.) is calculated by estimating the calcium held after removing the excess of calcium acetate solution and displacing the calcium by finally leaching with dilute acid. Some of the values obtained by using a slight modification of this method are given in Table I. In this, ordinary funnels fitted with Whatman filter-paper No. 40 were used and calcium was estimated by versenate titration after neutralising the acid with sodium hydroxide solution using a litmus paper. The volume of the acid used for the final leaching was 100 ml. Plants which were nearly three and a half months old were up-rooted carefully from the Institute Farm late in February, 1958, the entangled soil was removed by washing them in running water in the irrigation canal and finally in distilled water. The roots were then excised, dried in the oven at 60° C. and powdered, 0·5 to 1·0 g. of the composite sample in triplicate were taken for each analysis.

TABLE I

Plant	C.E.C. in m.e./100 g. of dry root
Wheat	9·7±0·5
Barley	11·9±0·2
Linseed	22·5±0·1
Habrum	27·6±1·0
Peas	33·4±0·4
Gram	35·3±0·3

It is seen from this table that the dicotyledons have higher values than the monocots as reported in literature (1) and that the values for wheat and barley agree with the values of 9·0 and 12·3 reported by Drake, Vengris and Colby[5] using an entirely different method consisting of electro-dialysis and titration to an extent better than those of Schuffelen and Middelburg who obtained values of 13·5 and 17·5 respectively.

My thanks are due to Dr. B. Ramamoorthy, Physical Chemist of this Institute, for his guidance during the course of this work.

Division of Chemistry, S. P. JAIN.
Indian Agricultural Research Institute,
New Delhi-12,
May 23, 1958.

1. Devaux, Quoted in Bear, F. E., "The Chemistry of the Soil," *Amer. Chem. Soc. Monograph*, 1954, No. 126, 292.
2. Arnon, D. I., Fratzke, W. E. and Johnson, C. M., *Plant Physiol.*, 1942, **17,** 515 and 525.
3. Ramamoorthy, B. and Desai, S. V., *Indian J. Agric. Sci.*, 1946, **16,** 103.
4. Williams, D. E. and Coleman, N. T., *Plant and Soil*, 1950, **2,** 243.
5. Drake, M., Vengris, J. and Colby, W. G., *Soil Sci.*, 1951, **72,** 139.
6. Gray, D. M. and Colby, W. G., *Proc. Soil Sci. Soc. Amer.*, 1953, **17,** 235.
7. Mattson, S. and Kontler, A. E., *Lanthr Högsk. Ann.*, 1943, **11,** 207.
8. Mattson, S. and Larson, K. G., *Ibid.*, 1945, **12,** 221.
9. Elgabaly, M. M. and Wiklander, L., *Soil Sci.*, 194, **67,** 419.
10. Graham, E. R. and Baker, W. L., *Ibid.*, 1951, **72,** 435.
11. Schuffelen, A. C. and Middelburg, H. A., *V Int. Cong. Soil Sci.*, 1954, **2,** 348.

THE OCCURRENCE AND FUNCTION OF THE PROVISIONAL EMBRYONIC CUTICLE OF *TENEBRIO MOLITOR* (COLEOPTERA)

In the eggs of *Tenebrio molitor* reared at 30° C. and 90% R.H. the provisional embryonic cuticle started forming about 96 hours after the laying of the eggs. This cuticle sloughed off on the sixth day and a new cuticle started forming in its place. The epidermis showed intense activity during the time of secretion and moulting of the cuticle. On the fifth and sixth day a large number of multicellular, tubular dermal glands made their appearance in the region of the epidermis. These glands are provisionally regarded as moulting glands because of their appearance only at the time of moulting of the provisional cuticle.

One of the chief functions of the cuticle is to act as an exoskeleton to resist the pull of attached skeletal muscles. So, careful observation was made to find any relationship existing between the embryonic cuticles and developing skeletal muscles. At the time of deposition of the provisional embryonic cuticle (96 hours after the deposition of the eggs) the muscles were only being differentiated from a group of myoblast cells (Fig. 1). The myoblast were

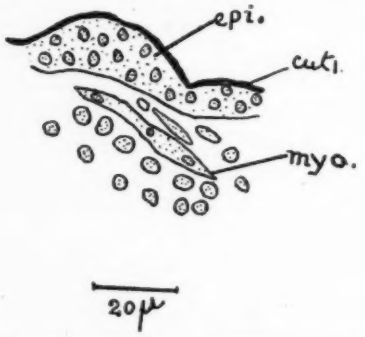


FIG. 1. *epi.*, epidermis; *myo.*, myoblast; cut_1, provisional embryonic cuticle.

first observed with certainty 24 hours earlier. The muscles were contiguous with the epidermis during embryogenesis. These skeletal muscles, at such an early stage of their development, were not in a position to gain attachment with the provisional embryonic cuticle. So the skeletal muscles gained attachment with the second embryonic cuticle on the seventh day, i.e., just before the emergence. The attachment of the muscles to the second embryonic cuticle was effected through tonofibrils, which are ectodermal in origin (Henneguy, 1906). Attachment is also indicated by the appearance of striations in the muscle fibres. In *Tenebrio molitor* nuclei disappeared completely from that part of epidermis where tonofibrillæ were formed (Fig. 2).

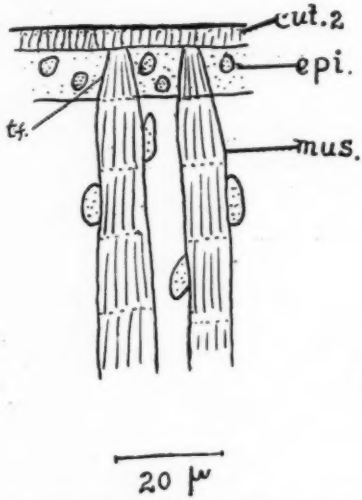


FIG. 2. *epi.*, epidermis; cut_2, second embryonic cuticle; *mus.*, striated muscle fibres, *tf.*, tonofibrillæ.

It is clear, therefore, that a deposition of the provisional embryonic cuticle does not synchronise with the developing muscle fibres. So to do away with this anomalous position the provisional embryonic cuticle is shed so that the skeletal muscle may gain attachment with the second embryonic cuticle.

I wish to thank Dr. B. M. Jones of the Edinburgh University, for his help in this work.

Department of Zoology, Science College, Patna-5, *August* 16, 1958.

R. K. SHARAN.

1. Henneguy, F., *Assoc. C.R., Anat.* (8th Reunion, Bordeax), 1906, 133.

OVIPOSITIONAL HABITS OF *DACUS* SP. (TRYPETIDAE : DIPTERA)

In Mysore State *Coccinia indica* N. & A. (Cucurbitaceæ), apart from being cultivated as a vegetable, is also found growing wild, in which state it is found very commonly attacked by *Neolasioptera cephalandræ* Mani causing stem galls.

Apart from the stem gall midge, *C. indica* is also subject to infestation by three species of *Dacinæ* in Mysore (Puttarudriah and Usman,

1954). In the course of investigation it has been observed that *Dacus* sp. apart from infecting tender fruits of *C. indica* may also attack the stem galls caused by *N. cephalandræ* and successfully completes a life-cycle therein. Fig. 1 shows two dissected stem galls containing

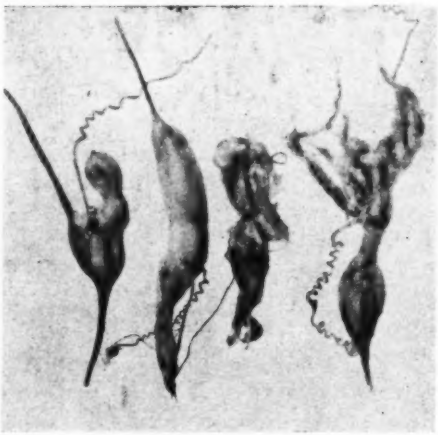


FIG. 1. Photograph showing *Dacus* sp. Larvæ and pupæ in *Coccinia* stem galls.

larvæ and pupæ of the fruit-fly. The infested stem galls lose their turgidity and become pulpy. In the course of the larval development of the fruit-fly, the maggots of the midge *N. cephalandræ* are completely destroyed.

Dacinæ are known also independently to cause the formation of galls on cucurbits. Back and Pemberton (1917) have recorded instances of *Ceratitis capitata* Wied. ovipositing and causing galls to develop on the vines of squash and cucumber in Hawaii. Mani (1953) has reported the occurrence of galls on the stems of *Cucumis* sp. caused by *Dacus cucurbitæ* Coq. In a personal communication, he observes, "a plant gall also is a part of the plant that can and does serve as a good and suitable food material" and added that he had once observed in a locality at Agra where every gall on a *Coccinia* plant had been oviposited by *Dacus* sp. This habit of *Dacinæ* is very interesting and further studies are in progress with reference to the seasonal incidence, survival ratio and parasite complex of *Dacus* sp. infesting *Coccinia* stem galls.

I am grateful to Dr. M. Puttarudriah, Government Entomologist, for his interest and encouragement. My sincere thanks are due to Dr. M. S. Mani, Deputy Director, Zoological Survey of India, for information on stem galls caused by *Dacinæ*.

Division of Entomology, Department of Agriculture, Seshadri Road, Bangalore-1, *September* 15, 1958.

D. V. MURTHY.

1. Back, E. A. and Pemberton, C. E., *U.S.D.A. Bull.*, 1917, **491**, 57.
2. Mani, M. S., *Agra Univ. Jour. Research (Science)*, 1953, **2**, 135-58.
3. Puttarudriah, M. and Usman, S., *Mys. Agric. J.*, 1954, **30** (4), 257–62.

AN INSTANCE OF HERMAPHRODITISM IN THE INDIAN MACKEREL *RASTRELLIGER CANAGURTA* (CUVIER)*

WHILE instances of hermaphroditism are known to occur in the European mackerel (*Scomber scombrus* L.),[1-2] no such cases are on record for the Indian mackerel, *Rastrelliger canagurta*. It is interesting to report, therefore, the occurrence of a single hermaphrodite specimen of *R. canagurta* in a sample taken from the fish market at Karwar and reported to have been caught at Majali, seven miles north of Karwar on 25th March 1958. Both in external appearance and in the other features of the internal anatomy, no abnormalities were noticed in the specimen. It measured 21·4 cm. in total length.

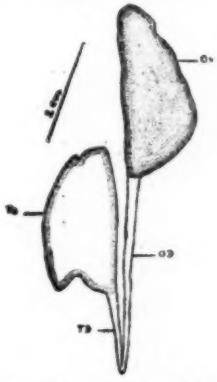


FIG. 1. Showing the relative position, shape and size of the gonads. OV : Ovary; OD : Duct of the ovary; TS : Testis; TD : Duct of the testis.

The left gonad, situated slightly anterior to the right one, was yellowish red in colour and showed the characters of an ovary in stage III of maturity. While the ovary, attached to the wall of the body cavity by a thin mesovarium

* Published with the kind permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.

was 1·7 cm. in length and 0·7 cm. in breadth, the oviduct commencing from the posterior end of the ovary measured 1·9 cm. in length. Microscopical examination of the ovary revealed the presence of yellowish yolky eggs ranging in size from 0·15 mm. to 0·31 mm. mixed with a large number of transparent immature eggs. The absence of larger eggs and the compactness of the ovary indicated that this fish was probably attaining maturity for the first time. The right gonad, connected to the dorsal wall of the body cavity by a thin mesorchium, was milk-white in colour in clear contrast to the left gonad and measured 1·4 cm. in length and 0·7 cm. in width with the duct running 0·8 cm. Microscopic examination of this gonad revealed the absence of eggs and the presence of cells similar to that of a normal testis. The genital ducts, lying parallel to each other very closely, appear to open outside through a common aperture. The relative position, shape and size of the two gonads and their ducts are shown in Fig. 1.

The hermaphrodite mackerel has been carefully preserved for further examination.

Central Marine Fisheries Research Unit, Karwar, *May* 16, 1958.

M. S. PRABHU.
B. T. ANTONY RAJA.

1. Dean, B., *Bibliography of Fishes*, 1923, **3**, 564.
2. Kyle, H. M., *Biology of Fishes*, 1926, 44.

A NOTE ON THE LEAF WEBBER *STRIGLINA SCITARIA*, WLK. ON *SESBANIA ACULEATA* (DAINCHA) IN MADRAS STATE

Sesbania aculeata is one of the important and popular green manure crops grown extensively in the Madras State. It is often subject to the attack of a number of Lepidopterous pests of which *Striglina scitaria*, Wlk. belonging to the family Thyrididæ was recorded as a pest in 1892 (Hampson). The author noticed it as a serious pest for the first time on this green manure crop at Coimbatore. The pest is seasonal in occurrence and the outbreaks are confined to the period July to November, although it remains active throughout the year in association with *Maruca testulalis*, Geyar. It has a wide distribution throughout India, Japan, Formosa, Ceylon, Burma, Andamans, Borneo, New Guinea, Australia and Fiji. Hampson (1892), Gater (1925) recorded the occurrence of this pest on *Erythrina* sp., *Bauhinia purpuria* and *Derris eliptica* in Malaya. It is also noted on *Cassia corymbosa* and *Notonia grandiflora* at Coimbatore.

The larvæ does maximum havoc to the leaflets by scraping the green matter. The young larvæ twist the terminal portions of the leaflets into small cones and live inside. The full-grown caterpillar webs together a number of leaflets and lives inside the tunnel and pupates.

Eggs are laid in a row on the edges of the leaflets in groups of 2 or 4. A single moth is capable of laying 25 to 30 eggs. The eggs hatch out in 2 or 3 days. The larval period ranges from 12 to 14 days during which it moults four times. The larvæ turns yellowish before pupation. Pupation takes place inside a cocoon of webbed leaflets with a coating of flimsy whitish silk. Pupal period lasts 6 to 8 days. The longevity of male and female moths ranged from 4 to 5 days with an average of 4·4 days.

The total life-cycle is about 20 to 25 days (Fig. 1).

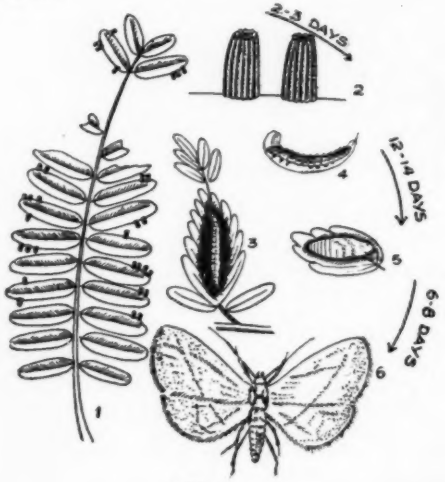


FIG. 1

The results of trials with synthetic chemicals to control the pest clearly indicated that the pest could be completely checked by spraying of 0·1% of BHC or 0·1% of Dieldrin.

The author expresses his deep sense of gratitude to Dr. Ramdoss Menon, Systematic Entomologist, I.A.R.I., New Delhi, and Dr. T. S. Sadasivan, Director, Botany Laboratory, Madras University, for offering valuable suggestions. He is also indebted to Sri. P. S. Narayanaswamy, Government Entomologist, for affording all facilities during the course of the investigations.

Entomology Division, Agric. Coll. & Res. Institute, Coimbatore, *August* 27, 1958.

S. VENUGOPAL.

1. Gater, B. A. R., "Investigations on Tuba," *Malayan Agric. J.*, 1925, **8** (10), 312-29.
2. Hampson, G. F., *Fauna of British India, Moths*, 1892, **1**, 354.

TEMPERATURE TOLERANCE OF THE LARVAE OF TEN SPECIES OF MARINE FISHES

A high rate of mortality among the larvæ was recorded when the yolk is absorbed and the digestive system of the pro-larvæ becomes modified to take in food in the post-larval stage. Such a problem confronted workers in the temperate regions also and the observations of Garstang (1900), Grawshay (1915), and Gross (1937), show that care has to be taken with regard to temperature, food, agitation of water and the attack of micro-organisms like ciliates and bacteria. Recent authors like Don Outram (1957) and Daniel (1952) also emphasized the importance of the temperature more than other factors. Attempts to rear the Marine fish larvæ in the laboratory both in this country and abroad have not met with uniform success. As far as the tropical species studied by the author are concerned, the larvæ appear to be affected mainly by temperature gradients. Therefore it was felt necessary to determine the temperature optimum for the larvæ of the different species of fish. To do this, larvæ just hatched from the eggs of each species of fish were left in specially devised bowls, which can be maintained at different temperatures.

The larvæ of each species of fish were maintained at different temperatures below 37° C., the highest surface temperatures of the sea recorded during the last three years at Madras. By keeping the larvæ at any particular temperature for a period of 12 hours and noticing the temperature level where the percentage of mortality was lowest the optimum temperature for the different stages of the larvæ of that particular species was ascertained. As the larvæ of different species of fish are hatched at different periods of the year when the temperatures of the air and of sea-water may vary, these data also were noted and included in Table 1. Since in a tropical place like Madras the temperatures of air and sea surface do not vary very widely during the different periods of the year, it is possible that the larvæ of the Madras species of fishes have a very narrow toleration range.

From Table I it will be evident that the early larvæ of *Cynoglossus lingua* and *Solea elongata* differ from their juveniles in their temperature relation. In the case of these two bottom living fishes the development is gone through at a temperature far lower than that of the surface of the sea. But in the case of all the remaining eight species the larvæ appear to require a low temperature from the time of

TABLE I

Showing the temperature tolerance and optimum temperature for development of the larvæ of 10 tropical fishes

No.	Name of fishes	Total No. of fishes used	No. of experiments performed	Period	Length in mm.	Temp. of air in ° C.	Temp. of sea-water	Optimum temp.	Toleration range
1	*Polynemus indicus*								
	Pro-larvæ and post-larvæ	286	8	1956 Nov.	2·2– 9·2	31–35	30–32	29	28–31
2	*Sardinella longiceps*								
	Pro-larvæ and post-larvæ	381	12	1956 Jan.	2·1–11·3	32–35	31–23	29	28–31
3	*Dussumieria acuta*								
	Pro-larvæ and post-larvæ	128	3	1955 July	2·6–14·2	32–35	31–33	30	29–31
4	*Caranx mate*								
	Pro-larvæ and post-larvæ	99	4	1955 Oct.	1·5–10·3	30–33	29–30	28	27–30
5	*Megalaspis cordyla*								
	Pro-larvæ and post-larvæ	196	7	1957 Feb.	1·9–10·2	33–36	30–31	29	28–31
6	*Mugil cephalus*								
	Pro-larvæ and post-larvæ	281	9	1956 June	1·1– 7·2	34–36	32–34	30	29–32
7	*Cynoglossus lingua*								
	Pro-larvæ and post-larvæ	98	3	1956 May	2·2– 6·9			29	28–30
	Juveniles	66	3		7·1–15·3	34–36	31–33	22	20–23
8	*Solea elongata*								
	Pro-larvæ and post-larvæ	102	4	1956 Feb.	1·6–11·2			30	29–32
	Juveniles	79	3		11·8–13·8	33–36	32–33	22	21–23
9	*Saurida tumbil*								
	Pro-larvæ and post-larvæ	296	6	1956 Jan.	2·8–20·4	32–35	31–33	30	28–31
10	*Triacanthus brevirostris*								
	Pro-larvæ and post-larvæ	92	3	1957 April	3·2–18·8	32–37	31–33	29	28–30

hatching up to the end of the post-larval period. Hence these larvæ were reared in the cooling chambers only upto this period. Beyond the post-larval stage up to the time of their metamorphoses into juveniles they tolerated a much higher temperature and were reared in the laboratory temperature in open bowls.

I am thankful to Prof. C. P. Gnanamuthu and Dr. G. A. Stevan for their valuable suggestions.

M. D. K. KUTHALINGAM.

Department of Zoology,
M.D.T. Hindu College, Pettai.
August 9, 1958.

1. Budd, P. L., "Development of eggs and larvæ of 6 Ca'ifornia fishes," *Cal. Fish and Game Bull.*, 1940, No. 56, 1-50.
2. Crawshay, L. R., "Notes on experiments in the keeping of Plankton animals under artificial condition," *Jour. Mar. Biol. Assn.*, 1915, **10**, 555-76.
3. Daniel, J. M., "Notes on the embryology and behaviour of the flying fishes," *California Dept. of Fish and Game*, 1957, **38** (4), 549-55.
4. Don, Outram, "The development of the Pacific Herring Eggs," *Turtox News*, 1957, **35** (1), 16-22.
5. Garstang, W., "Preliminary experiments on the rearing of the sea fish larvæ," *Ibid.*, 1900, **6**, 70-93.
6. Gross, F., "On the culture of some Marine plankton organisms," *Ibid.*, 1937, **21**, 753-68.

PINEAL ORGAN IN FISHES

THE present study on the pineal organ of catfishes shows that the organ is a well developed median glandular structure arising from the roof of the third ventricle with no sign of bilateral origin.

The observations are based on the studies of the following fishes.—*Mystus aor*, *Mystus seenghala*, *Mystus bleekeri*, *Mystus gulio*, *Mystus tengara*, *Wallago attu*, *Rita rita*, *Psedotropius murius*, *P. garua*, *Bagarius bagarius*, *Eatropiichthys vacha*, and *Clarius batrachius*.

From the roof of the third ventricle in-between the habenular ganglion and the posterior commissure comes out the pineal tract which is exceptionally long and has two accompanying blood vessels, all along its course. The pineal organ, the swollen terminal end of pineal tract, lies in a single median foramen termed the pineal foramen. This foramen is found in the frontal or in between the frontal and prefrontal region (Fig. 1).

The pineal organ and the pineal tract are glandular in nature and the former has no resemblance to any eye-like structure. In

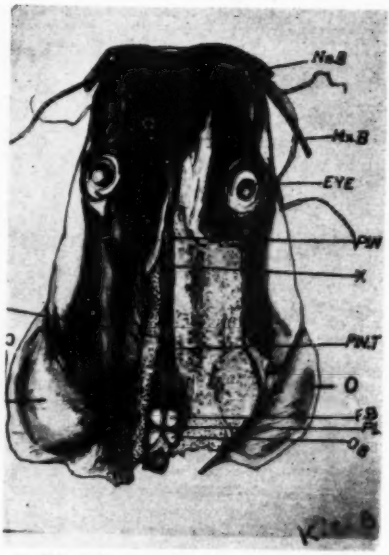


FIG. 1. Dissection showing the Pineal organ and tract *in situ Mystus aor* (Dorsal View), × ½.
F.B—Fore brain ;
Mx. B.—Maxillary barbel ; *Na B.*—Nasal barbel ;
O—Operculum ;
OB—Optic bulb ;
PIN.—Pineal organ ;
Pin. T;—Pineal tract ;
X—Pineal tract at this place gets thicker in diameter.

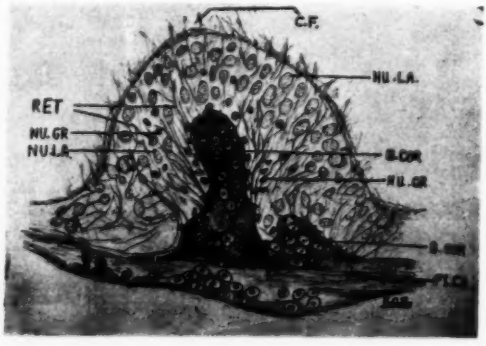


FIG. 2. Transverse section showing one of the finger-shaped processes of the Pineal organ of *Mystus aor*, × 400.
B. COR.—Blood corpuscles ; *FI. CR.*—fibrous covering ;
NU. GR.—Small deeply staining nucleus ;
NU. LA.—Large nucleus ;
C.F.—Cell processes projecting into the lumen of the pineal organ ;
RET—Reticulum.

adult specimens this organ does not show any sign of degeneration but grows with age.

Two types of cells are seen in the pineal system : one with the larger nuclei and the other with smaller nuclei. There is no cell-wall distinguishable in between. The cells and these nuclei are seen to be embedded in the network of the protoplasm. The nuclei are pigmented; the smaller one is much more granulated than the larger one. The nuclei can be differentiated into acidophilic and basophilic types (Fig. 2).

The lumen of the tract is continuous with the third ventricle at one end and the pineal organ at the other end. Some secretory patches are found in the lumen of the gland.

The histological structure of the pineal organ strongly indicates its glandular nature and in no case is the pineal organ a vestigeal structure. Further work is in progress.

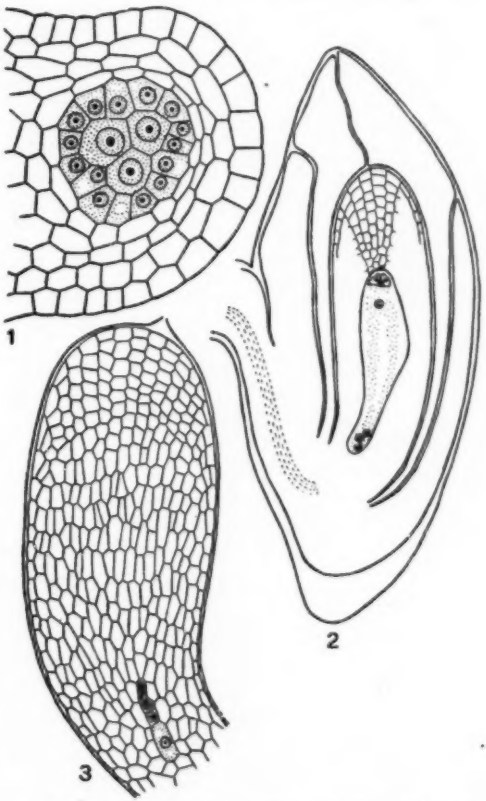
Univ. Dept. of Zoology, K. C. Bose.
Bihar University,
Ranchi,
August 6, 1958.

MICROSPOROGENESIS AND FEMALE GAMETOPHYTE IN *BOSWELIA SERRATA* ROXB.

The important embryological work in the family Burseraceæ is that of Wieger (1935) who studied 16 species distributed in 5 genera. Recent embryological work in the family is on *Balsamodendron mukul* (Shukla, 1954) and on *Garuga pinnata* (Narayana, 1957).

The anther structure in *Boswelia serrata* shows an epidermis and four wall layers of which the innermost functions as the tapetum which is of the secretory type (Fig. 1). The tapetal cells are uninucleate in early stages and become binucleate by the time the pollen mother cells begin to undergo meiosis. The cells of the hypodermal wall layer develop into the fibrous endothecium in the mature anther. The middle layers become crushed during further development of the anther. A feature of interest is that the epidermal cells of the anther show papillate projections. Similar papillate projections from the cells of the anther epidermis have been reported in Meliaceæ (Garudamma, 1957 & Narayana, 1958). Meiosis in the pollen mother cells is normal. Cytokinesis takes place by furrowing. Pollen tetrads show tetrahedral arrangement. The pollen grains are two-celled at the time of shedding. The exine is smooth and the pollen grains are 3-colperate.

The ovary is 3-carpellary syncarpous, 3-locular with two ovules in each loculus. The ovules are crassinucellate, bitegmic and hemianatropous (Fig. 2). The integuments are free from one another and form the nucellus (Fig. 2).



FIGS. 1–3. *Boswelia serrata*. Fig. 1. T.S. of young anther lobe showing the epidermis, wall layers and the tapetum surrounding the sporogenous tissue, ×910. Fig. 2. L.S. ovule showing the integuments, conducting strand and embryo-sac, × 230. Fig. 3. L.S. ovule showing the megaspore tetrad with enlarging chalazal megaspore, parietal tissue and the nucellar cap. Integuments not shown, × 680.

The inner integument which grows above the level of the outer, alone takes part in the formation of the micropyle. The conducting strand ends at the base of the chalaza (Fig. 2).

The primary archesporium in the ovule consists of a single hypodermal cell which can be distinguished by its possession of a larger nucleus and denser protoplasm. The primary archesporial cell cuts off a primary parietal cell before it becomes the megaspore mother

cell. A parietal tissue of several layers of cells is formed as a result of repeated periclinal and anticlinal divisions in the primary parietal cell (Fig. 3). The cells of the nucellar epidermis also undergo periclinal divisions resulting in the formation of a nucellar cap (Fig. 3). The megaspore mother cell undergoes meiosis and a linear tetrad of megaspores is formed (Fig. 3). The lowermost cell of this tetrad is functional (Fig. 3) and develops into the embryo-sac after three successive free nuclear divisions (Fig. 2), while the upper three become crushed during the development of the embryo-sac. Thus, the development of the embryo-sac in *Boswelia serrata* follows the normal type and it shows the usual organisation with an egg apparatus consisting of two synergids which show hooks and an egg, three antipodals and two polar nuclei which fuse in the middle. The embryo-sac enlarges during development and most of the parietal tissue becomes crushed.

The author expresses his grateful thanks to Prof. J. Venkateswarlu who suggested the problem and under whose guidance this work was completed at the Andhra University.

Department of Botany, Osmania University, Hyderabad-Dn. 7, *August* 21, 1958.

L. L. NARAYANA.

1. Garudamma, G. K., *J. Indian bot. Soc.*, 1957, **36**, 227.
2 Narayana, L. L., *Sci. and Cult.*, 1957, **23**, 248.
3. —, "Floral Anatomy and Embryology of *Cipadessa baccifera* Miq.," *J. Indian bot. Soc.*, 1958, **37**, 147-154.
4. Shukla, R. D., *Curr. Sci.*, 1954, **23**, 333.
5. Wieger, J., "Embryological studies in the families Buxaceæ, Meliaceæ, Simarubaceæ and Burseaceæ," *Diss. Lund*, 1935.

CHROMOSOMES OF FIVE INDIAN AND CEYLONESE GRASS SPECIES

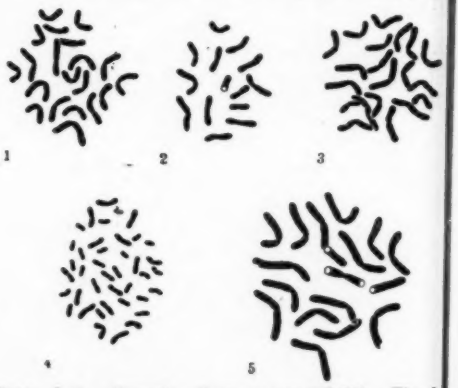
FOR the natural classification of Gramineæ the examination of chromosome features of various species is needed. For this purpose, the root tips of some Indian and Ceylonese grasses were fixed with Navashin solution by the writer during his sojourn in India and Ceylon. After his return to Japan, they were dehydrated and embedded in paraffin. Sections were cut at 15 micra and stained by Newton's gentian violet method.

Five species whose chromosomes are reported here are listed in Table I. The counts in two species of *Arundinella* are new, while there are previous reports for the chromosomes of the three other species.

TABLE I

Species	Localities	$2n$	Fig.
Arundinella villosa Arn. ex Nees	Dulva Kanda (Ceylon)	14	2
A. blephariphylla Trim. ex Hook. f.	Peradeniya (Ceylon)	20	1
Garnotia scoparia Thw.	Dúlva Kanda; Dambulla Rock (Ceylon)	20	3
Perotis patens Gand.	Cuttack (India)	40	4
Spinifex littoreus Merr.	Madras (India)	18	5

In *Arundinella*, two basic chromosome numbers occur; $b = 7$ and 10. Moriya and Kondo[1] observed $n = 14$ in *A. hirta* Tanaka; Tateoka[2] found $2n = 56$ in the same species. These numbers are suggestive of the basic number of 7, and the present observation on *A. villosa*, showing $2n = 14$ clearly indicates the presence of basic 7 which is rather unusual in Arundinelleæ and related tribes. On the other hand, Ramanathan[3] reported $2n = 20$ for *A. setosa* Trin. The same number is found in *A. blephariphylla* (Fig. 1).



FIGS. 1–5. Somatic chromosomes, × 2,000. Fig. 1. *Arundinella blephariphylla*. Fig. 2. *A. villosa*. Fig. 3. *Garnotia scoparia*. Fig. 4. *Perotis patens*. Fig. 5. *Spinifex littoreus*.

These two species may be diploids representing the basic number of 10.

Tateoka[6] pointed out a similarity of leaf structure in *Arundinella* and *Garnotia*. *G. scoparia* has the basic number of 10, showing $2n = 20$ which accords with Ramanathan's observation. The chromosome morphology of *Arundinella* and *Garnotia* is very similar as shown in Figs. 1-3. These facts indicate a relationship between the two genera. For *Perotis patens* two different chromosome numbers were reported; $2n = 36$ (de Wet and Anderson[4]) and $2n = 40$ (Moffett and Hurcombe[5]). The

present observation accords with the latter. *Spinifex littoreus* is a dicœcious plant. Unfortunately the writer could not distinguish the sex of the individual used because it was not flowering.

National Institute of Genetics, T. TATEOKA.
Misima, Sizuoka Pref.,
Japan.
August 18, 1958.

1. de Wet, J. M. J. and Anderson, L. J., *Cytologia*, 1956, **21**, 1.
2. Moffett, A. A. and Hurcombe, R., *Heredity*, 1949, **3**, 269.
3. Moriya, A. and Kondo, A., *Jap. Jour. Gen.*, 1950, **25**, 126.
4. Ramanathan, K., *Curr. Sci.*, 1950, **19**, 155.
5. Tateoka, T., *Cytologia*, 1954, **19**, 317.
6. —, *Bot. Gaz.* (in press).

THE OCCURRENCE OF POLY-HUSKED SPIKELETS AND OTHER ABNORMALITIES IN RICE PANICLES

AT the Central Rice Research Institute, Cuttack, while studying the inheritance of some characters in the F_3 generation of certain cross-combinations within the *indica* group of rices, three types of abnormalities in rice panicles were noted in three plants of the population. These are described below.

(*a*) *Poly-husked Spikelets.*—In the cross W. 703 × Ac. 1780, one of the panicles in a plant showed the presence of certain spikelets with extra husks (Fig. 1). Of the 33 spikelets on this panicle, 14 were poly-husked, 15 were normal and 4 were sterile and filamentous. In the poly-husked spikelets, although the reproductive organs were present (in many cases in reduced condition), none of them bore any seed. The number of extra husks varied from one to five with the mode at three. In size, 20·9% of the extra husks were half as long as the lemma, 41·8% equal to the lemma and 37·3% about one and a half times to twice the length of lemma. In addition to the presence of poly-husked spikelets on the panicle, a vegetative branch consisting of a rosette of thin, short, somewhat curled stiff leaves, arose from the panicle node. Kuang *et al.* (1946) observed a number of poly-husked spikelets on a panicle, both in *japonica* and *indica* groups of rices. These extra husks varied in number from one to five and in size were, same length as lemma, smaller than lemma or very much longer than the lemma. Jordon (1957) reported the occurrence of an extra long lemma or an extra glume between the lemma and the outer glume in the F_2 of cross 852, and found

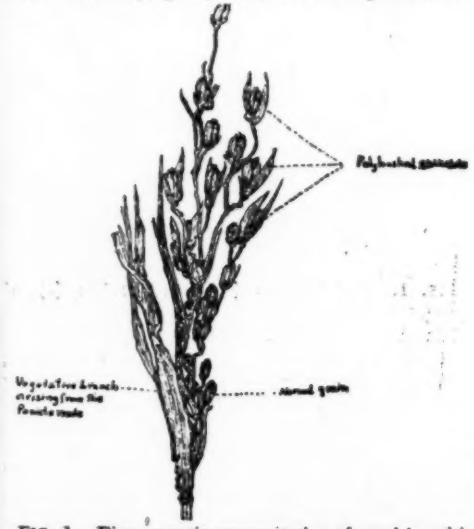


FIG. 1. Diagrammatic representation of panicle with poly-husked spikelets and vegetative branch from the cross W. 703 × Ac. 1780 (natural size).

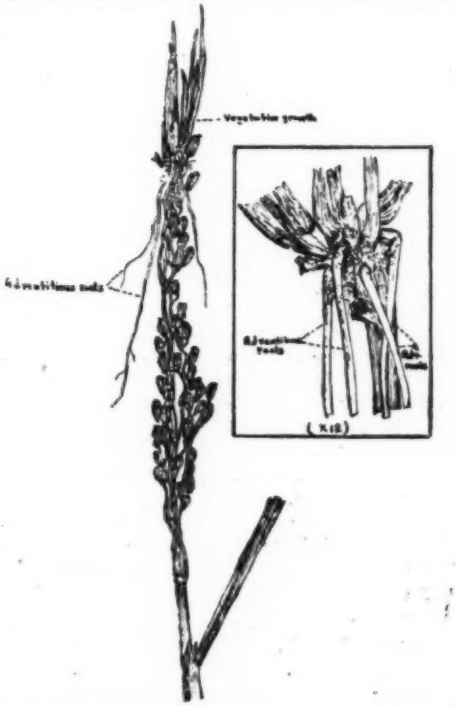


FIG. 2. Diagrammatic representation of panicles with adventitious roots arising from the base of the upper vegetative part from the cross Ac. 1780 × Ac. 1765 (natural size) [Inset × 12].

this condition to be simple recessive to normal, the same as reported by Kuang *et al.* (*loc. cit.*)

(*b*) *Adventitious Roots.*—In another cross Ac. 1780 × Ac. 1765, a number of adventitious roots were found to develop on the upper parts of the panicle (Fig. 2), a few of them measuring 4 to 8·5 cm. in length. They arose from the base of the upper part of the panicle, which had become vegetative and turned into a cluster of narrow stiff leaves. The position of roots arising from this bunch of leaves, was either from the base of the scaly leaves or from in between the scaly leaves (Fig. 2). Jones and Pope (1942) observed panicles with adventitious roots in the X-rayed rice variety *Caloro* and later on, in a panicle of the *Nira* variety. These roots were noted by them to arise in some spikelets, somewhere between the lemma and the abcission layer of the seed, while in others they arose below the first glume. The presence of adventitious roots was found by these authors to be simple recessive to the normal condition.

(*c*) *Variegated Spikelets.*—A number of variegated patterns have been described and their inheritance studied by various workers. These variegations have consisted of striped patterns confined to the first 2-3 leaves in the seedling stage only. Pal and Ramanujam (1941), however, have described one variegated plant in which the green and white striping persisted in the mature plant and later spread to grains as well. In the cross W. 703 × Ac. 1780, one plant was found poorly developed and showed striping of white and green, which extended from the leaf-sheath to all other parts of the plant including the panicle and spikelets. The white stripes were rather in excess of the green ones and gave the plant a silvery grey appearance. The panicle was compact, stunted, with a number of small round grains, many of which were sterile.

Seeds have been collected from these abnormal types and have been grown during the current crop season for studying their behaviour and possible utilization in genetical research.

Central Rice Research Institute, Cuttack, *September* 3, 1958.

W. T. BUTANY.
N. R. NAIR.

1. Jordon, N. E., "Inheritance of some of the more striking characters in rice," *J. Hered.*, 1957, **48**, 181-82.
2. Jones, J. W. and Pope, M. N., "Adventitious roots on panicles of rice," *Ibid.*, 1942, **33**, 55–58.
3. Kuang, H. H., Chiang, Y. H. and Tu, D. S., "Studies on the variation of polyhusks in cultivated rices," (*O. sativa* L.), *J. Genet.*, 1946, **47**, 260–71.
4. Pal, B. P. and Ramanujam, S., "A new type of variegation in rice," *Indian J. Agric. Sci.*, 1941, **11**, 170–76.

AN UNDESCRIBED SPECIES OF *CERCOSPORA* ON *ANOGEISSUS ACUMINATA* WALL.

GROWING along the bank of the river *Mahanadi* in the district of Sambalpur, large and beautiful trees of *Phansi* (*Anogeissus acuminata* Wall.) were observed to be infected by apparently an undescribed species of *Cercospora* towards the end of March 1958. The disease appears on the lower surface of the leaves as fuligenous patches of irregular size which often coalesce and involve a major portion of the leaf surface. At a later stage the infected leaves abscise and fall off quite earlier than the unaffected leaves.

Cercospora acuminata spec. nov. (Fig. 1)

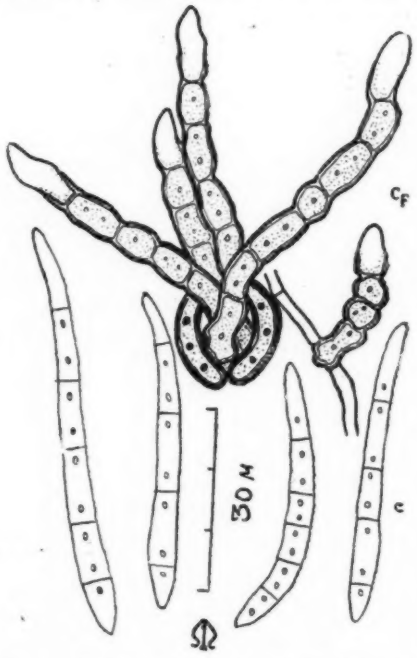


FIG. 1. Conidiophores (*cp.*) and conidia (*c*) of *Cercospora acuminata* Das.

Maculæ non distinctæ; fructificationes hypophyllæ effusæ, circulares vel irregulares, 2-5 mm. diam. sæpe coalescentes, olivaceæ; stromata minuta vel nulla; conidiophori crassis parietibus præditi, breves, non ramosi, geniculatione inconspicua, brunnei, pallidiores ad apicem, breviter septati, frequenter constricti ad septa, globulis olei ornati, emergentes per stomata singuli vel fasciculati, stipitibus 2-5, magnitud. 21-57 μ × 4·5-5·5 μ (42·6 × 5 μ); conidia subhyalina, recta Vel tenuiter curvata,

bis ad quinquies septata, obconica ad basin, subobtusa ad apicem, olei globulis ornata, magnitud. 27-90 $\mu \times 3 - 4{\cdot}5\,\mu$ ($51{\cdot}45 \times 4\,\mu$).

Typus lectus in foliis *Anogeissus acuminatæ* Wall. ad locum Sambalpur die 14 februarii anni 1958 a S. N. Das et positus in herbario collegii agriculturæ in Statu Neo-Eboracensi in Universitate Cornelliana et in herb. *Crypt. Ind. Orient.*, I.A.R.I. in New Delhi (Sub numero acquisitionis 25981).

As far as the author can ascertain, this is probably the first report of *Cercospora* occurring on a member of Combretaceæ. The fungus is, therefore, recognized as a new species and named as *Cercospora acuminata*.

Thanks are due to Prof. C. Chupp and L. R. Batra of Cornell University, U.S.A., for helping in identification; to Rev. Father Dr. H. Santapau, St. Xavier's College, Bombay, for rendering the Latin descriptions and to Dr. U. N. Mohanty, Deputy Director of Agriculture, Cuttack, for his encouragements.

Mycology Research Wing, Utkal Krushi Mahavidyalaya, Bhubaneswar (Orissa), *August* 28, 1958. SITANATH DAS.

DISCOVERY OF VIRULENT ISOLATES OF RACE 42 B OF *PUCCINIA GRAMINIS TRITICI* IN BOMBAY STATE

THE occurrence of biotypes within the Indian races of stem rust of wheat was first proved by Uppal and Gokhale[2] who showed that two field isolates of race 42 were entirely different in their pathogenic behaviour from the original culture of that race established by Mehta.[1] The biotype 42 A is differentiated from race 42 by its virulence on Khapli wheat only while the biotype 42 B is differentiated from both by the reactions of Yalta wheat which is highly susceptible to 42 B but resistant to 42 and 42 A.

Stem rust occurred in an epidemic form in parts of Bombay State in 1956-57 when E. 572 (Ridley), an exotic wheat, and selection No. 146 from the cross (Gaza × Local Baxi 23) were found to be susceptible under field infection although both of them were known to be resistant to the commonly occurring Indian races of stem rust in seedling and field tests. Pure cultures established from the pustules of susceptible type occurring on these varieties proved to be race 42 B. Both E. 572 and selection No. 146 are resistant to the original culture of race 42 B maintained at Mahabaleshwar. E. 572 proved susceptible to the field isolate from that variety but resistant to the isolate from selection No. 146 and *vice versa*. Similarly, a sample of stem rust on local wheat from Kurkutte in Marathwada Region, which also proved to be race 42 B on differential and accessory hosts, was found to be more virulent to Kenphad wheat than the original culture of race 42 B. These three isolates of race 42 B were, therefore, compared between themselves and also with the original culture of race 42 B by testing some more wheat varieties against all of them in the seedling stage. The results are given in Table I. The new isolates are

TABLE I

Seedling reactions of ten wheat varieties to race 42 B and its three new isolates

	Variety of wheat	Race 42 B	New isolates		
			42 B-1	42 B-2	42 B-3
			Seedling reactions		
1	Kenphad 28	X	3 and 4	3 and 4	4 and 4
2	do. 39	X	X	X	3 and 4
3	(Gaza × Motia)-59	2	2	X	2
4	(Gaza × Jaya)-125	2	2	X	2
5	(Gaza × Baxi 23)-146	2	2	(Mostly 3 and 4) do.	2
6	Charter	2	2	3 and 4	2
7	Gaza	2	2	3	2
8	Hybrid 65	2	2	4	2
9	E. 572	2	3 and 4	1 and 2	2
10	Dundee 48	2	3 and 4	2	2

designated as follows: the isolate from E. 572 as 42 B-1, that from (Gaza × Baxi 23)-146 as 42 B-2 and that from Kurkutte local wheat as 42 B-3.

It will be seen that the isolates 42 B-1 is virulent to E. 572 and Dundee 48 but not to Charter, Gaza, Hy. 65 and selections 59, 125 and 146 from crosses with Gaza as the resistant parent while the isolate 42 B-2 is virulent to varieties which are resistant to 42 B-1. All these eight varieties (Nos. 3-10 in Table I) are, however, resistant to race 42 B. This shows that both the isolates, *viz.*, 42 B-1 and 42 B-2, are not only different from and more virulent than race 42 B but each of them can be regarded as a separate race. The isolate 42 B-3 differs from race 42 B and the two isolates mentioned above only in the degree of susceptibility of two Kenphad wheats. The remaining eight varieties are resistant to both 42 B and 42 B-3. Hence the isolate 42 B-3 may be regarded as merely a virulent isolate or biotype of 42 B and not a separate race.

The discovery of biotypes within Race 42, particularly 42 B, was of great significance to the wheat breeders. The present discovery of more virulent isolates in race 42 B makes their task still more complicated and difficult. Varieties like Charter, Gaza and E. 572 which are resistant to all the commonly occurring races of stem rust in India, including 42 B, are susceptible to one or the other of these new isolates. Till now, Gaza was the only *durum* variety with high or moderate resistance to all the Indian races of stem rust, except 15 C (Gokhale[3]) which, however, is of rare occurrence. Since Gaza is susceptible to the isolate 42 B-2, the rust resistant selections from crosses between it and the high yielding but rust susceptible improved *durum* wheats of the new Bombay State and Mysore might prove susceptible if that isolate, which was picked up from one of such selections, increases in prevalence.

The discovery of the biotypes and further isolates in race 42 has also an important bearing upon the procedure followed for testing wheat varieties and hybrids for stem rust resistance under artificial epidemics. It is necessary to expose the promising rust resistant varieties or hybrids to natural infection of stem rust at a large number of places, especially where the conditions for the development of infection are quite favourable.

The authors are grateful to Dr. M. K. Patel, retired Plant Pathologist to Government, Bombay State, for his help in the preparation of manuscript.

Bombay,
July 25, 1958.

V. P. Gokhale.
B. P. Patil.
M. K. Desai.

1. Mehta, K. C., *Sci. Monogr. Imp. Counc. Agric. Res.*, 1940, 14.
2. Uppal, B. N. and Gokhale, V. P., *Curr. Sci.*, 1947, **16**, 61.
3. Gokhale, V. P., *Ibid.*, 1950, **19**, 214-15.

CHROMOSOME NUMBER IN PANDANALES

The order Pandanales includes the family Pandanaceæ, Typhaceæ and Sparganiaceæ. Of these the chromosome numbers of a few species of *Pandanus* (Tjio, 1948; Harada, 1949), *Typha* (Roscoe, 1927; Heiser & Whitaker, 1948: Harada 1949) and *Sparganium* (Harada, 1949) have been determined. As very little work has been done on the plants occurring in India, belonging to the above three families, the present work was undertaken with a view to work out the anatomy, embryology and cytology of *Pandanus utilis*, *P. odoratissimus*, *Freycinetia funiculare*,* *Typha angustato* and *T. elephentina*. The following is a preliminary account of the cytology of the plants studied so far. The chromosome numbers determined during the course of the present study are as follows:

Table I

Name	Chromosome Number n	Chromosome Number $2n$
Pandanus utilis Roxb. ..	30	60
P. odoratissimus Roxb. ..	30	60
Freycinetia funiculare Merr.	25	X
Typha angustata Chaub. ..	15	30 also determined by Harada (1949)
T. elephentina Roxb. ..	15	30

It may be pointed out in this connection that the recorded chromosome numbers of *Pandanus pacificus* & *P. pygmæus* by Tjio (1948) is the same as determined for the species under study. However, Harada (1949) records $2n = 64$ for *P. boninensis*, and $2n = 30$ for some species of *Typha*. Heiser & Whitaker (1948) also state $2n = 30$ for the different species of *Typha* except *T. angustifolia* L. where they find $2n = 60$.

The chromosomes of both the species are extremely small and exhibit dimorphism. The number and morphology of the somatic chromosome have been studied by prefixing the root-tips in æsculine, coumarine and α-bromonaphthalene followed by aceto-orcein squash method. Salt-chromosomes have been observed in the somatic complement of all the plants investigated. Study of meiosis has been completed. A full account of the cytology of the plants investigated will be presented elsewhere.

The above work was conducted from a grant of the C.S.I.R. and has been carried out under the guidance of Dr. I. Banerji, to whom my grateful thanks are due.

(Mrs.) Bidyut Gunguly.
Department of Botany,
Calcutta University,
Calcutta,
August 20, 1958.

* Material was kindly handed over to me by Prof. P. Maheshwari, which was collected from Java.

1. Harada, I., *Cytologia*, 1949, **14** 214.
2. Heiser, C. B. Jr. and Whitaker, T. W., *Amer. J. Bot.*, 1948, **35** 179.
3. Roscoe, M. V., *Bot. Gaz.*, 1927 *a*, **84**, 392.
4. Tjio, Joe Hin, *Hereditas*, 1948, **34**, 135.

REVIEWS

Royal Society Mathematical Tables, Vol. IV. (*Tables of Partitions.*) By Hansraj Gupta, C. E. Gwyther and J. C. P. Miller. (Cambridge University Press.) Price 3 £ 3 *sh.* net.

The theory of the partition of integers into different parts is one of the most beautiful branches of Number Theory and finds application in diverse subjects like combinatory analysis, group theory and statistical mechanics. In the present tables, values are given for $p(n, m)$ which is the number of partitions of n into at most m parts, and three other functions $p_2(n, m)$, $p_3(n, m)$ and $p_4(n, m)$ which are defined only mathematically and are given by the relations

$$\sum_{n=0}^{\infty} p_s(n, m)\, t^n = \prod_{r=1}^{m} \frac{1}{(1-t^r)^s} \prod_{r=m+1}^{\infty} \frac{1}{(1-t^r)^{s-1}}$$

$$(s = 1, 2, 3, 4 \ldots)$$

The tables are preceded by an introductory chapter explaining the symbols used, their interconnections and the methods adopted for the computation of the functions, and an excellent bibliography for the subject of partitions of numbers. The introductory chapter reads as a good introduction to the subject of partitions itself and supplies formulæ for $p(n, m)$ for three different cases, namely, (1) when m is comparable with n; (2) when n is small and (3) in the asymptotic case of large values of n. When $m = 0$, the last case reduces to the asymptotic expansion for $p(n)$, the number of unrestricted partitions of n into integers which is a problem solved by Hardy and Ramanujan in one of their famous papers. Table I tabulates the values of $p(n, m)$ in the first instance for values of m from 1 to 100 and of n from 1 to 200, and secondly when $n > 200$, for all values of m from 1 to 50 and for n up to 400. Table II gives the values of $p_2(n, o)$ $[p(n)]$ for values of n up to 1,000 and the values $p(n, m)$ for small values of m. Table III tabulates the function $p_3(n, m)$, and in Table IV are given the values of $p_4(n, o)$ or $p_3(n)$ for integral values of n up to 200.

The tables would prove to be beneficial to all scientific institutions wherein the programme of work calls for the numerical application of partition functions. The authors and publishers deserve to be congratulated for bringing out this edition which is a product of arduous labour and excellent printing workmanship.

K. S. VISWANATHAN.

Nuclear Scattering. By K. B. Mather and P. Swan. (Cambridge University Press, London N.W. 1), 1958. Pp. viii + 469. Price 80 *sh.*

The subject of nuclear scattering has recently been exhaustively reviewed in several volumes of the *Handbuch der Physik*. Those who want a briefer account of this topic will welcome this book in the series of Cambridge Monographs on Physics. It deals mainly with the scattering of nucleons by nucleons and very light nuclei, where it is possible to investigate the detailed form of the nuclear two-body interaction.

Chapter 1 introduces concepts of nuclear physics necessary for an understanding of nuclear scattering. Chapters 2 to 4 are devoted to general experimental methods and are discussed only in the special context of scattering technique. This is more or less a review and adequate references are given to the original papers. Chapter 5 contains graphs of range-energy relations for charged particles in various materials, and will serve as a ready reference.

Two chapters are devoted to the theory of low-energy neutron-proton and proton-proton scattering and introduces the well known concepts of effective range and scattering length. In this region there is excellent agreement between theory and experiment. A further chapter discusses the low-energy scattering of nucleons by very light nuclei. The introduction of more particles makes calculations much more difficult and the authors show that the work done so far is inexact and incomplete. It becomes necessary to take into account the non-central interactions, namely, the tensor and the spin-orbit interactions which are important, for example, in the scattering of nucleons by α-particles.

This is followed by two chapters on high-energy scattering. The discussion of this work leads to no definite conclusion about the details of the nucleon-nucleon interaction but the method of approach given here has been followed in the recent very important work of Signell and Marshak, and Gammel and Thaler. In this section the deuteron stripping reaction is introduced and reviewed in some detail.

Many other related topics are discussed briefly, for example, nuclear saturation, meson theory of nuclear forces, the optical model and the Breit-Wigner dispersion formulæ. Considering the size of the book, the account is quite comprehensive. It is well illustrated with diagrams and figures, and has a very complete list of references. It will be very useful to research workers and post-graduate students, but the price (80 *sh.*) is rather high.

G. A.

Rockets, Missiles and Space Travel. By Willy Ley. (Chapman & Hall, London W.C. 2 ; India : Asia Publishing House, Bombay-1), 1957. Pp. xv + 528. Price 50 *sh.*

This book is a useful contribution to the rapidly increasing library on 'Conquest of space' literature.

A good half of the book is devoted to the historical background and chronological development of Rockets. Starting from the time of the Babylonians, the author describes in an elaborate and yet interesting manner the evolution of modern Rocketry.

This book should particularly interest those who believe that a combination of suitable rocket fuels and a rocket motor will make a flight to the Moon possible within the near future. However, to those who may deem it all that simple, the author's personal experience in the enormous technical problems which face teams engaged in Rocket Research, in the Chapters 'Peenemunde' and 'White Sands' (the two famous rocket research centres) will be immensely educative. Any project on rocket research involves the automatic functioning of a host of different components and the failure of even a single component in the System dooms to failure the whole project. Therefore, checks, rechecks, counter-checks must be applied first and last at all stages of the development programme. A clear insight to problems like escape velocity, exhaust velocity, mass ratio, etc., which are very important in the launching of a rocket is given in the Chapter, "The Rocket into Cosmic Space". In the Chapters "The Shot Around the World" and "The Spaceship", the future possibilities and uses of launching of future artificial satellites both unmanned and man-manned are described.

The book was published in March 1957 and so does not include the successful launching of the artificial satellites. Of course, as the author himself expresses, with the rapid progress done in this field, one cannot expect a book of this type to be up-to-date. Nevertheless information on rocket research done till the early days of 1957 has been adequately covered.

In conclusion, with the evolution of the Rocket Airplane admirably described in Appendix I, the useful notes, tables and diagrams—of which there are 84—the book attains substantial reference value, besides being useful and instructive to both the specialist and non-specialist alike.

B. M. C.

Polymer Reviews—The Effects of Ionizing Radiation on Natural and Synthetic High Polymers. By Frank A. Bovey. (Interscience Publishers, New York), 1958. Pp. xiii + 287. Price $ 8.00.

This volume is the first of a series of reviews to be published on subjects of lively and topical interest in polymer science. The choice of the radiation chemistry of high polymers as the first in the series is quite appropriate. Apart from the technological and theoretical interest, the subject is linked up inextricably with the problem of human welfare. In the light of the continuous radioactive pollution of earth's atmosphere by nuclear explosions and the general awakening throughout the world to the genetic hazards of radiations, the importance of the subject can never be over-emphasised.

The volume begins with a concise and balanced treatment of radiochemistry which is followed by an introduction to the chemical effects of radiations. Against this essential background, a general account of the radiation chemistry of high polymers is presented in the third chapter. The principal reactions induced by radiations namely scission and cross-linking and the statistical methods of treating the phenomena constitute the subject-matter of the succeeding chapter. This is followed by a detailed presentation in six chapters the results of the extensive investigation of the physical and chemical changes brought about by radiations on synthetic and natural polymers. The diverse types of synthetic polymers are grouped together under different heads from the standpoint of structure such as hydrocarbon polymers, acrylics, halogenated polymers, diolefin polymers and condensation polymers. The natural polymers and their derivatives are given a separate treatment in the last chapter. No knowledge of the structure of the polymeric materials is presupposed on the part of the reader and prior to the presentation of radiation chemistry a brief account of the structure of the polymer is also given. This undoubtedly

enhances the utility of the book and would interest a wider class of readers. Another notable feature of the book consists in the presentation of the radiation chemistry of small molecules structurally related to polymers, as a prelude to the discussion of the radiation chemistry of the polymer. This approach proves to be of immense efficacy in stressing upon the nature and the type of interaction of the vulnerable sites of the macromolecule with radiation.

The volume is a critical and competent survey of one of the rapidly advancing fronts in polymer science and is a welcome addition to the existing treatises on the subject. The author has presented much scattered and even some of the inaccessible information in a very concise and readable manner. As the first of the series, it has set up an excellent standard and one would wish that the succeeding volumes of the series keep up the standard of the first volume.

The printing is excellent and free of mistakes.

S. L. KAPUR.

Number Average Molecular Weights. By Robert U. Bonnar, Martin Dimbat and Fred. H. Stross. (Interscience Publishers, New York, London), 1958. Pp. 310. Price $ 7.50.

The determination of molecular weights of solutes is a common routine laboratory experiment described in texts for undergraduates. Since Beckmann's classical experiments, for a considerable time very little beyond refinements in techniques found their way into textbooks. Except under osmotic pressure, the monograph on Physical Methods of Organic Chemistry does not give an adequate treatment and the volume under review fills a gap. The study of compounds of high molecular weights has revealed often considerable differences between different methods and a monograph dealing with all the methods including viscosity average and weight average (centrifugal) methods would have been desirable. The present volume is of strictly restricted scope dealing only with the number average methods alone.

The subject is dealt in eight chapters starting with an introductory survey with cryoscopic, ebullioscopic, osmotic pressure, vapour pressure, vapour density and functional group methods each forming a chapter and the theory of the first two methods forming a separate chapter.

Every chapter gives a clear picture not only of the conditions to be fulfilled for precision measurements but also the pitfalls in each case. Where alternative procedures are adopted, we see a critical appreciation of these so that an investigator can make his choice. The cryoscopic method rightly emphasises the factors which vitiate experimental results and amongst them is one not commonly mentioned in the routine texts: reduction in solubility of a solute by the presence of another apparently inert substance. The chapter on ebulliometry is complementary to that of Swieteslowski in *Techniques of Organic Chemistry* and we have a useful account of using this procedure in determining molecular weights up to 20,000. The volume is specially valuable for a thorough discussion of the theory of these methods. Following Lewis and Randall, expressions are derived which lead to the need for not only the conventional cryoscopic or ebullioscopic constant but second and third terms in the integrated form of the Clapeyron equation. Where precision measurements are needed, one has to know precisely the errors involved and the basis on which these can be eliminated. The fourth chapter gives us a very useful picture of this aspect.

Under vapour pressure lowering methods, both thermoelectric and isopiestic methods are described. The reviewer is unable to agree with the author that Barger's method of isothermal distillation 'was novel and not very accurate'. As a micromethod, with very simple equipment, this method gives as accurate values as many others with more complicated equipment. The last two chapters give a brief account of recent techniques in vapour density and functional group methods.

The book is well produced and both the contents and the treatment make it a valuable addition to any laboratory training students of Physical Chemistry.

S. V. A.

Organic Electrode Process. By Milton J. Allen. (Chapman & Hall Ltd., London), 1958. Pp. xi + 174. Price 32 *sh.*

The author has given a lucid account of the techniques of Electro-organic Chemistry and has discussed in detail the factors affecting the course of organic oxidations and reductions brought about by the influence of electric current. The reduction of nitro compounds, of imines and imidic esters, aldehyde and ketones, carboxylic acids, esters, amides and imides as well as some complicated systems such as alkaloids, aliphatic-substituted compounds,

sulphamated compounds, unsaturated compounds etc., are all discussed. Similariy the oxidation of aliphatic acids and their salts with special reference to Kolbe reaction, oxidation of alcohols, aldehydes, ketones, sugars, carboxylic acids, alicyclic compounds, etc., are also discussed in detail. A chapter is devoted towards anodic substitution reactions. A perusal of the subject-matter as well as the references shows that the book is rather outdated since there appears to be but scanty references to the work done during the last decade, with the result that some of the important developments have not been included in the book.

The presentation of the subject-matter is satisfactory with very few errors.

K. S. G. D.

Methods of Biochemical Analysis, Vol. VI. Edited by Glick. (Interscience Publishers, New York), 1958. Pp. ix + 358. Price $ 9.50.

Methods of Biochemical Analysis, the sixth one of the annual series, is now published. It is a most welcome addition which has quite maintained the tradition of previous volumes, so far as the wealth of materials and the varieties of newer techniques and methods dealt with in this volume are concerned. The volumes published uptill now really constitute a "self-modernizing encyclopædia" of methods of biochemical analysis. The progress of science depends considerably on the development of newer techniques and the refinement of the older ones already in use. That is why so much emphasis is given now-a-days on the methodology and instrumentation for all branches of science.

The current volume covers a variety of methods including physical, microbiological, chromatographic, electrophoretic, etc., for the determination, mostly in micro amount of the important biochemical constituents, particularly nucleic acid, serotonin, enzymes, vitamins, etc. Of exceptional importance is the procedural details of the different methods given in the book which are not always available to the workers interested in them. The contributors of this volume are either pioneers or have personal experience in the development of the methods they have discussed. So it is needless to add that a book with such a stamp of authority will be most welcome to all biochemists and other workers in the allied branches of science.

M. C. NATH.

Irrigation and Hydraulic Design (Vol. II)—**Irrigation Works.** By S. Leliavsky. (Chapman & Hall, London W.C. 2; India: Asia Publishing House, Bombay-1), 1958. Pp. xiv + 864. Price 294 *sh.*

The author has attempted to write a comprehensive treatise covering all aspects of irrigation and hydraulic design in three volumes. Volume I deals with general principles of hydraulic design, Volume II with designing and planning of perennial canal schemes, and theory of irrigation works including regulators, cross-drainage works, siphons, weirs and other canal structures from the smallest to the gigantic sizes. The third volume which is to be shortly published will deal with all types of sizes of diversion works, on alluvial rivers and electrification of irrigation works.

Dr. Leliavsky has undertaken this stupendous task single handed. His experience covers over 40 years which includes service with the Russian Government on the Hydroelectric Works of the Dnieper Project and the Irrigation Department of the Egyptian Government.

The second volume begins with a chapter on design of regulators of all sizes. The Egyptian practice has been discussed thoroughly. The discussion on the hydraulics of the flow of the water from the weirs has been thorough from purely theoretical point of view. As is well known, mere mathematics cannot give a correct answer in many cases and the author could have stressed on the usefulness of model studies. Under such conditions, model studies alone can give a dependable answer.

In the chapter dealing with the hydraulic works, a reference could have been made to what in India are called Relieving Weirs to dispose of the surplus water from canals. The practice of having intermediate regulators, and cross-canals is not in vogue in this country. As the author has rightly pointed out, this induces other troubles like those of silting and encouragement of weed growth, while it may be helpful in maintaining a good head at the tail end. While discussing the various types of falls, it has been correctly pointed out that the hydraulic ideal would be satisfied if the water level over the crest of irrigation work would vary precisely in the same manner as in the canal it controls. Thus for every discharge slope, the canal should remain the same, so that, all the outlets whether at the head or at the tail of the canal takes its appropriate share of irrigation water in all conditions. The Indian design of notch type of falls approaches

this ideal to the greatest extent possible (p. 334). In this respect, the American designs mentioned require further improvement. While discussing the design of automatic siphon spillways, the author is apparently not aware of the recent work done in India. The world's biggest siphons each 18 feet diameter of the Ganesh Iyer's type are working efficiently at the Mahatma Gandhi Hydroelectric Works in Mysore State. The important point to be considered with the design of siphon is the priming depth in relation to the diameter of the siphon. This has not been discussed. Another point that could have been discussed is the limitation of the height of the siphon barrel at the crest. The discharge in a siphon is not increased proportionately with the increase in the diameter of the siphon barrel at the crest. The author has done well in describing clearly the Prasil's flow net diagrams for fixing the exact shape of the trajectory flow over the spillway. This knowledge is very useful as the reviewer does not know of any other book dealing with this important subject. The author has made a statement that to reproduce cavitation in a model, the zero pressure must be taken equal to the vapour pressure p_v. He gets the equation :

$$p_a' = p_v + \frac{p_a - p_v}{n}.$$

The problem for scaling down is not as simple as that. Experiments have shown that cavitation depends on the solid-gas-nuclei content of the water. It is not known whether any correlation exists at all between Reynolds Number of the flow and inception of cavitation in the turbulent region of the flow. It is not possible to obtain a functional relationship between model experiments and prototype performances with our present knowledge of cavitation phenomenon. It should also be understood that cavitation damage is not scalar. While discussing the characteristics of the spillway flow, the author has stressed only on the design of the spillway free from any negative pressure. This restricts the coefficient of discharge over the weir. It is well known that the discharge for the same length of the weir can be increased by designing a weir (as has been successfully done by the reviewer) with negative pressure at the crest and these are called high coefficient weirs in India. As long as the pressures are above cavitation pressures, there need be no fear of vibrations or other instability problems. While designing a perennial irrigation scheme, the various anti-malarial measures necessary have also to be considered. In India, it has become a standard practice to leave a margin of a furlong or so round every village where cultivation is restricted for only dry crops. This is done to prevent water-logging in the villages coming under the command of the canals. Soil surveys and crop planning data are also necessary for designing of a perennial irrigation scheme.

The few remarks made above are intended to make the future editions of the book even more useful. The treatment of the subject has been thorough both from the historical and the analytical points of view. This is a book which every irrigation engineer ought to possess. The book contains well over 700 diagrams, charts and tables. The price, considering its excellent get-up and its value to designers, is not too high.

N. S. Govinda Rao.

Isotopic Tracers in Biology—An Introduction to Tracer Methodology, Third Edition. By Martin D. Kamen. (Academic Press, Inc., Publishers, New York ; India : Asia Publishing House, Bombay-1), 1957. Pp. 474. Price $ 9.50.

It must have been immensely satisfying to Dr. Kamen, the co-discoverer of Carbon-14, to watch the field of research pioneered by him and a few others to expand and cover a vast territory including many disciplines of scientific research.

The first edition of this book came out in 1947 when isotopic tracers were a novelty in many laboratories. It was immediately accepted as a standard text-book for the frontier science of tracer methodology. The popularity of the isotopes in biological research grew exponentially in the following years and a second edition had to be brought out in 1951. The third edition has long been overdue.

"The objective", as the author puts it, "of this third edition is the same as those defined in the first edition. The main task in preparing it has been to evaluate new material covering many aspects of a number of fields, some not even mentioned in the first edition. I am tempted to borrow the diplomatic phrase 'agonizing re-appraisal' to describe the difficulties inescapable in such a process."

In fact, the author has packed together an unbelievable amount of material within a book of a comparatively small size and as a result, the current edition, apart from attaining its obvious objective, meets the requirement for a supplementary text-book for subjects, such as biology, physiology, biochemistry and medicine.

The most impressive section of this book comprises of three chapters on the survey of tracer methodology in which the application of tracers in biological processes has been reviewed. After dealing with the principles and limitations of the tracer technique, the author proceeds on to diverse subjects, such as the dynamic state of cell constituents, the concept of metabolic pool, precursor-product relationships, metabolic cycles, isotopic competition, Ogston's hypothesis about the stereospecificity of the enzymes of the Kreb's cycle, reversibility of biochemical-equlibria and the mechanism of enzyme reactions.

In the next chapter a masterly treatment is given to three selected topics in intermediary metabolism, *viz.*, the pathway of carbon dioxide in photosynthesis, the biosynthesis of cholesterol and the biosynthesis of porphyrins, the elucidation of which can be regarded as the outstanding achievements of tracer research.

Dr. Kamen in his brief but sparkling review has been able to recreate the thrills and excitement marking these great events in biochemistry.

In the third part of this section a wide cross-section of material has been presented in connection with the applications of tracers in physiology, immunology, chemotherapy and medicine.

The reviewer fails to understand the significance of putting the last four chapters dealing with the chemistry of various isotopes at the end of the book. These should have been brought forward to follow the first three chapters—where they logically belong.

An unfortunate and probably unwitting lapse from the high standard maintained throughout the book is the structure of DPNH given on p. 176. The formula for DPNH as shown was accepted up to 1954 but has undergone revision since 1955. However, the third edition has not only kept up to the standards set by the previous editions but also has surpassed them in many respects.

P. K. Bhattacharya.

Thermodynamics of One Component Systems. By W. N. Lacey and B. H. Sage. (Academic Press Inc., Publishers, New York; India: Asia Publishing House, Bombay-1), 1957. Pp. xi + 376. Price $ 8.00.

Among engineering sciences thermodynamics is the oldest. The analysis and design of specific engineering systems require a comprehensive appreciation of the varied facets of thermodynamics—the breadth and usefulness of which is implied in the first and second laws.

This book is intended to meet the needs of engineering students in thermodynamics. The book is divided into two parts. Part I which consists of seven chapters deals with basic thermodynamic principles. The various terms are defined clearly and adhered rigidly throughout. The First and Second Laws of thermodynamics and their applications are logically and lucidly discussed. The general thermodynamic equations are derived and tabulated.

In Chapter 4, the behaviour of perfect and real gases is treated. While compressibility factor is dealt with, no mention is made of the "Amagat Unit". Irreversible processes and reactions between systems of constant weight and systems of variable weight are next dealt with. This latter is of considerable engineering importance.

In Part II is dealt Flow Processes. The flow of fluid through a plant may be steady flow or unsteady flow, *i.e.*, variable with respect to time. The latter is not treated in this book. The mechanics and thermodynamics of steady flow processes in view of its engineering importance are presented in great detail. The usual steady flow cycles such as Carnot, Rankine, Regenerative, Reversed, divided and multiple fluid cycles are uniquely treated in a single chapter enabling the student to a better appreciation of the same. A chapter each has been devoted to prime movers of engineering importance, *viz.*, steam turbine, steam engine and compressors. Refrigeration and liquefaction of gases form the concluding two chapters.

A noteworthy feature of the book is a brief discussion in Appendix I of the methods used in the determination of Thermodynamic properties.

The get-up of the book leaves nothing to be desired. This well-written book is a welcome addition to the numerous text-books on Thermodynamics.

A. R.

Chemotherapy and the Central Nervous System. By Henry McIlwain. (J. A. Churchill Ltd., 104, Gloucester Place, London W. 1), 1957. Pp. viii + 328. Price 45 *sh.*

Dr. McIlwain's book *Chemotherapy and the Central Nervous System* is an expensive volume and is probably meant to be used as a text-book by students to learn some of the outstanding facts on chemotherapy with reference to Central Nervous System. It is didactic

in its tone and has a bibliography attached to each chapter; most of the references are from among the English authors. The historical anecdotes given in the various chapters of the book are interesting and give a picture of the advances that have been made during the course of time by authors working with different approaches in trying to understand the problems of chemotherapy. These anecdotes can also be fairly easily remembered.

The subject has been discussed in twelve chapters; there is also an author and subject index. The accepted formulæ of many of the drugs now in use have been presented, perhaps, to show the possibility of synthesis of some of these drugs; the specific action of any one part of the molecule is, however, not indicated. The last two paragraphs of each chapter show, in a summary form, the work done so far towards the specific chemotherapeutic processes and the possible lines of advance of knowledge that might take place in the coming years. The assay of many of these chemotherapeutic drugs during the metabolism in the human body are indicated but are not given in sufficient detail, for which other books and the works of other authors have to be consulted. The graphs shown in many of the chapters are simplified to reveal and to impress the memory of the results that have been obtained by various authors during their experimentation on chemotherapeutics.

The typing and format are excellent. The publishers have, as usual, given an excellently bound book. There seems to be no typographical errors.

The book can well be recommended to any post-graduate student for understanding various aspects of neuro-chemistry and the approach towards the treatment and chemotherapeutic measures evidenced by the vast quantity of work that has been done during the last few years. The author is to be congratulated on producing a very valuable textbook in a field in which there is not much available literature, presented in an easily understandable form.

M. V. Govindaswamy.

A Revision of the Genus *Camellia*. By J. Robert Sealy, Royal Botanic Gardens, Kew. (Published by the Royal Horticultural Society, Vincent Square, London S.W. 1), 1958. Pp. 240. Price 3 £ 10 *sh*.

Students of the tea plant will welcome the publication, by the Royal Horticultural Society, of J. Robert Sealy's *A Revision of the Genus* Camellia. Mr. Sealy has been engaged on this for nineteen years and it fully justifies the labour. As exquisite colour plate by Stella Ross-Craig draws attention to the horticultural possibilities of the genus. Species are illustrated by drawings notable for their clarity and of great value to the taxonomist. Descriptions of the species in this difficult genus are presented for the first time in a convenient and accessible form. Special attention is given to the tea plant. More than one species has made its contribution to cultivated tea, and the taxonomic affinities given by Sealy must necessarily be taken into account by specialists, botanical and otherwise, who wish to extend our fundamental knowledge of this important crop. The format of the book maintains the high standard expected of the publishers: one hopes that its reception in India will be followed by a national collection of living specimens that might, in time, rival the camellias of the Huntington Gardens in America.

W. Wight.

Enzymes in Blood (*Annals of the New York Academy of Sciences*, Vol. 75, Art 1). (New York Academy of Sciences), 1958. Pp. 384.

This volume is a collection of papers presented at a Conference held by the New York Academy of Sciences in February 1958. The stated objective of the volume is to "increase the contact between clinical investigators of blood enzymes and members of other groups, such as enzymologists and physical chemists, so that.... each might gain in understanding and some increased ability for his own investigations". More than eighty participants report their latest findings under five major headings: Enzymes in White Blood Cells, Enzymes in Red Blood Cells, Enzymes in Blood Coagulation and in Platelets, Serum Enzymes and their Origin, and Clinical Significance of Blood Enzymes. Time and space do not permit a detailed coverage of the material (which took two days to present). It ranges from "Leukocyte glycolysis: an investigation of the Factors Controlling the Rate Behaviour in Multienzymo Systems" by William S. Beck to "Immunochemical Studies on Alkaline Phosphatase" by Max Schlamowitz, with papers on Carbohydrate, Protein and Nucleic Acid Metabolism and Blood Coagulation sandwiched in between.

So wide is the coverage of subject-matter that any scientist with any biochemical propensity whatever will find much to interest him. The volume is well edited and will be

a very worthwhile addition to the bookshelf of the biochemist and clinician.

T. RAMAKRISHNAN.

The Indian Zoological Memoirs. [Monograph No. 6 on The Indian River Prawn, (*Palæmon*)]. (Published by the Zoological Society of India). Pp. 102. Price Rs. 5·0.

The issue of a second edition of the Indian Zoological Memoir on the Indian River-Prawn, *Palæmon*, though long overdue since its first publication in 1937, will be warmly welcomed by students and teachers of Zoology in the steadily increasing numbers of Universities and Colleges in the country. It is to be hoped that when a revised edition of the Memoir is contemplated, the following will be borne in mind: the addition of a key to the Indian species of *Palæmon* and of a separate chapter on Embryology, and the enlargement of Chapter XII on Bionomics and Distribution. A short bibliography of essential literature referred to in the text on the subject-matter of the Memoir may prove to be a useful addition.

The price of the Memoir is reasonable considering that the quality of printing and get-up equals that of the contents.

H. S. R.

Books Received

Nuclear Magnetic Resonance. By H. S. Gutowsky, F. C. Nachod and others. (*Annals of New York Academy of Sciences*, Vol. 70, Art 4.) Pp. 763-90.

Gypsum and Anhydrite. By A. W. Groves. (H.M. Stationary Office, London S.E. 1). 1958. Pp. iv + 108. Price 7 *sh.* 6 *d.*

Metals and Enzyme Activity. Edited by E. M. Crook. (Cambridge University Press, London N.W. 1), 1958. Pp. 102. Price 21 *sh.*

Cosmic Electrodynamics. By J. W. Dungey. (Cambridge University Press, London N.W. 1), 1958. Pp. ix + 184. Price 32 *sh.* 6 *d.*

Scientific Uses of Earth Satellites. By J. A. Van Allen. (The University of Michigan Press; India: Asia Publishing House, Bombay-1). Pp. x + 316. Price $ 10.00.

The Exploration of Space by Radio. By R. H. Brown and A. C. B. Lovell. (Chapman & Hall, London W.C. 2; India: Asia Publishing House, Bombay-1), 1957. Pp. xii + 207. Price 35 *sh.*

Instrumentation in Testing Aircraft. By C. N. Jaques. (Chapman & Hall, London W.C. 2; India: Asia Publishing House, Bombay-1), 1957. Pp. xi + 291. Price 45 *sh.*

Report for 1957, Rothamsted Experimental Station, Harpenden, Herts. (Rothamsted Experimental Station, Harpenden, Hedts), 1958. Pp. 316. Price 10 *sh.*

Space Exploration. By P. Moore. (Cambridge University Press, London N.W. 1). Pp. 36. Price 3 *sh.*

Modern Geometrical Optics. By M. Herzberger. (Interscience Publishers, New York-1), 1958. Pp. xii + 504. Price $ 15.00.

Mind and Matter. By Erwin Schrodinger. (Cambridge University Press, London N.W. 1), 1958. Pp. vii + 104. Price 13 *sh.* 6 *d.*

Gas Turbines for Aircraft. By A. W. Judge. (Chapman & Hall, London W.C. 2), 1958. Pp. vii + 439. Price 60 *sh.*

Science and Education at the Cross Roads. By J. W. Still. (Public Affairs Press, Washington 3 D.C.). Pp. viii + 140. Price $ 3.75.

Progress in Crystal Physics, Vol. 1. By R. S. Krishnan. (S. Viswanathan Central Art Press, Acton Lodge, Madras), 1958. Pp. vi + 198. Price Rs. 20.

Solving the Scientist Shortage. By D. C. Greenwood. (Public Affairs Press, Washington 3 D.C.). Pp. viii + 68. Price $ 2.00.

Adventures in the World of Science. By C. G. Abbot. (Public Affairs Press, Washington 3 D.C.). Pp. ix +150. Price $ 3.50.

Proceedings of the Symposium on Ground Water. (Central Board of Geophysics, Calcutta-16), 1955. Pp. xvi + 400.

Advances in Enzymology, Vol. 20. Edited by F. F. Nord. (Interscience Publishers, New York-1, N.Y.). Pp. vii + 488. Price $ 12.50.

Patterns of Discovery. By N. R. Hanson. (Cambridge University Press, London N.W. 1), 1958. Pp. ix + 240. Price 30 *sh.*

General and Inorganic Chemistry for University Students. By J. R. Partington. (Macmillan & Co., London W.C. 2). Pp. xxiii + 927. Price 60 *sh.*

Integral Equations.—Cambridge Tracts in Mathematical Physics. By F. Smithies. (Cambridge University Press, London), 1958. Pp. vii + 172.

SCIENCE NOTES AND NEWS

National Institute of Sciences of India

Applications are invited for the undermentioned Research Fellowships. The Fellowships are tenable for two years at any University or Institution in India. Particulars and application forms are obtainable from the Secretary, National Institute of Sciences of India, Mathura Road, New Delhi 1. Request for forms should be accompanied by a self-addressed and 25 nP. stamped envelope of 9" × 4" size, indicating thereon the name of the Fellowship for which forms are required. Four copies of application on prescribed form should be sent. Copies of published papers as evidence of research and an outline of the proposed scheme of research are to be submitted with each application form. Closing date for receipt of applications is 7th March 1959.

National Institute of Sciences Senior Research Fellowships.—The value of the Fellowship is Rs. 500 p.m.; in addition, Rs. 1,000 is available for approved expenses per year. *Age*: Below 45 years. *Qualifications Essential*—(*i*) Master's Degree in Science of a recognised University. (*ii*) Experience of independent research.

National Institute of Sciences Junior Research Fellowships.—The value of the Fellowship is Rs. 400 p.m.; in addition, Rs. 600 is available for approved expenses per year. *Age*: Below 35 years. *Qualifications Essential*—(*i*) Master's Degree in Science of a recognised University. (*ii*) Research Experience.

Raptakos Medical Research Fellowships

The Raptakos Medical Research Board Fellowships for the year 1959 have been awarded to the following candidates: (Miss) B. N. Uma, Indian Institute of Science, Bangalore-3; Prafulla J. Dave, Hæmatology Clinic, J.J. Group of Hospitals, Byculla, Bombay-8; G. V. G. Krishna Rao, Nutrition Research Laboratories, Coonoor; Anil R. Sheth, Indian Cancer Research Centre, Parel, Bombay-12; Kshitish Chandra Das, Institute of Post-Graduate Medical Education and Research, Calcutta-20.

Award of Research Degrees

The University of Bombay has awarded the Ph.D. Degree in Botany to Shri T. R. Thyagarajan for his thesis entitled "Cytological Phenomena Succeeding Spoi ulation in *Saccharomyces carlsbergensis*".

The Gujarat University has awarded the Ph.D. Degree in Physics to Shri K. M. Kotadia of Physical Research Laboratory, Ahmedabad, for his thesis entitled "Studies in Ionospheric Physics in Low Latitudes".

The University of Poona has awarded the Ph.D. Degree in Chemistry to Shri V. Anantharao Saraf for his thesis entitled "Studies in Isomerization and Conjugation of Some Drying Oils", and the Ph.D. Degree in Biochemistry to Shri M. S. Naik for his thesis entitled "Studies in Riboflavin in Higher Plants".

Osmania University has awarded the Ph.D. Degree in Physics to Messrs. M. Ramakrishna Rao, M. Suryanarayana and Bansigir K. Goswami for their theses entitled "Light Scattering and Viscosity Studies of Some Polymer Solutions", "Ultrasonic Studies in Chemically Active Liquid Media" and "Photo Elastic Dispersion in Crystals" respectively.

Indian Botanical Society

The following have been elected as Office-bearers for the year 1959: President—Dr. E. K. Janaki Ammal, Allahabad; Vice-Presidents—Dr. R. Misra, Banaras, Dr. P. Maheshwari, Delhi; Hony. Secretary—Dr. J. Venkateswarlu, Waltair; Hony. Librarian—Dr. R. Misra, Banaras; Hon. Treasurer and Business Manager—Dr. T. S. Sadasivan, Madras.

The Indian Society of Genetics and Plant Breeding

At the 19th Annual General Meeting of the Indian Society of Genetics and Plant Breeding, held on 23rd January 1959, at New Delhi, the following were elected as Office-bearers of the Society for 1959: President—Dr. R. H. Richharia, Vice-Presidents—Dr. A. B. Joshi, Prof. P. N. Bhaduri; Secretary—Dr. M. S. Swaminathan; Treasurer—Dr. N. L. Dhawan; Editor—Dr. B. P. Pal.

International Conference on Semiconductor Physics in Prague, 1960

Czechoslovak Academy of Sciences organizes International Conference on Semiconductor

Physics which will be held in Prague from 29th August to 2nd September 1960 under the auspices of the International Union for Pure and Applied Physics and which will continue the series of Conferences held in Reading 1950, Amsterdam 1954, Garmisch-Partenkirchen 1956 and Rochester 1958.

The Secretary of the Organization Committee has the following address: Dr. Milos Matyas, Institute of Technical Physics, Prague 5, Cukrovarnicka 10, Czechoslovakia.

The Indian Society of Theoretical and Applied Mechanics

At the Fourth Congress of the above Society which was held at the Bengal Engineering College, Howrah, from December 29 to 31, 1958. the following Office-bearers were elected: President (for 2 years): Dr. A. N. Khosla; Vice-President (*vice* Sri. V. Cadambe retired): Dr. S. K. Chakravarty; Secretary and Treasurer (for 3 years): Prof. B. R. Seth. New Members of the Executive Committee: Dr. Jai Kishan, Prof. B. Sen Gupta and Prof. D. Banerjee.

Standardization of Columns for Gas-Liquid Chromatography

At the International Symposium on Modern Methods of Analytical Chemistry, held at the Louisiana State University, January 26-29, 1959, Dr. B. Sen, who has been a Visiting Assistant Professor at Louisiana State University for four years, discussed critically the recommendations of the second symposium on Gas Chromatography. The standardization of columns in gas-liquid chromatography is a matter of considerable importance and the existing methods are extremely complicated to perform. He showed that by reproducing the chromatogram—a representation of Bernoulli trials—the total number of trials and the probability of success can be predicted and so the column conditions can be specified. Based on his theoretical work substantiated by experimental data, Dr. Sen told that the new technique, which does not involve any kind of correction factor, may be considered as an absolute means of standardization.

The Fluorocarbons

Till some ten years ago relatively few carbon-fluorine compounds were known, but in the past decade many hundreds of them have been synthesised by a variety of methods. They are based on the chemical combination of carbon with fluorine and are closely related to the carbon-hydrogen systems of orthodox organic chemistry.

However, whereas the hydrocarbons are highly inflammable, fluorocarbons are extremely non-inflammable and are unusually chemically stable. This is because the bond between the carbon and fluorine atom is an extremely stable one and also because the size of a fluorine atom is not too great to allow saturated fluorocarbon chains to exist without causing undue strain in the molecule.

In such compounds, fluorine atoms shield the backbone of carbon atoms and thus protect them from attack by chemical reagents, and this factor contributes to the great stability of the fluorocarbons, which are indeed almost as unreactive as the rare gases. They will resist attack by strong acids, alkalies, oxidising and reducing agents, and a great commercial future is possible for them for this reason. Many closely related compounds containing carbon, fluorine and either chlorine and/or bromine are excellent fire extinguishers and they have revolutionised the refrigeration and aerosol industries. This is due in part to their great chemical stability and the ease of handling them under slight pressure.

A remarkable method of fluorination of organic compounds has been developed by the American chemist Simons and his colleagues. The organic compound to be fluorinated is dissolved in anhydrous hydrogen fluoride and electrolysed at voltages below those necessary for the liberation of free fluorine. Fluorocarbon compounds with a typical functional group have readily been made; for example, fluorocarbon carboxylic acids, sulphonic acids, ethers and tertiary amines which are of great potential importance.

In recent years an intensive study has been made by Dr. Tatlow, and his students, on the fluorination of benzene. This compound when fully fluorinated gives perfluoro*cyclo*hexane C_6F_{12}. However, in addition to the fully fluorinated materials it is possible to synthesise flurohydro*cyclo*hexanes, *cyclo*hexenes and *cyclo*hexadienes. Chemical processes are now available to enable the remaining hydrogen atoms in a hydrofluoro*cyclo*hexane or hexene to be removed and the important compound, fluorobenzene, C_6F_6 has been synthesised. The preparative techniques have been rapidly developed so that this important compound is now available in significantly large quantities and its reactions are being compared with those of benzene. It will be readily apparent that the vast number of carbon-ring-containing or "aromatic" compounds already known may be paralleled with an equally large number of hexafluorobenzene aromatic compounds. Already

the fluorophenols, fluoroanilines and fluoro-dye-stuffs have been synthesised. The discovery of fluorobenzene is of particular significance in the biological field, because every biologically important compound containing a benzene ring will in due course have its fluoro analogue. Perhaps the greatest potential use for the fluoro-compounds will be in making fluoro-rubbers and fluoro-plastics of high chemical and thermal stability. Yet another important application will be in the field of the silicones, where the replacement of certain of the hydrogen atoms by fluorine atoms gives a "fluorosilicone rubber" which is more resistant to heat and to conventional fuels than are the silicones. In the days to come in this age of ever faster-flying aircraft with higher "skin temperatures" there will be an increasing demand for non-inflammable construction materials of every description.

From the university teacher's point of view, fluorocarbon chemistry provides excellent discipline in synthesis and theoretical reasoning for the training of young research chemists. —Prof. Maurice Stacey, F.R.S., in *The New Scientist*, January 8, 1959.

Blow-Hole Theory of Lunar Craters

In the light of the recent discovery reported by the Russian astronomer of a volcanic eruption on the moon (*Current Science*, 1958, 27 (12), p. 512) the following observations of Gaydon and Learner (*Nature*, January 1959, 183, p. 37) will be of great significance. They suggest the possibility of lunar craters being caused by fountains of dust blown out by trapped gas.

Many years ago Dr. Gaydon observed that during rapid evacuation of a quantity of magnesium carbonate in a flask a number of blow-holes appeared as the occluded gas escaped, leaving a pattern of rings, some with central 'pimples', closely resembling lunar craters. After the recent announcement of the volcanic activity on the moon, they repeated the experiment using a variety of powders (sand, salt, magnesium oxide or magnesium carbonate) in a 5-litre flask, which was continuously evacuated; a small flow of air was admitted at the bottom of the flask by a small hole. Various forms of blow-hole, which simulated lunar craters, were observed. The form of the 'crater' varied with type of powder, its angle of slip, depth, and the rate of flow of gas.

It is known that terrestrial volcanoes may emit large quantities of dust and ash, but the presence of an atmosphere interferes with the free fall of the particles. On the moon with no atmosphere, lower gravity, and probably a dry 'sandy' surface, formation of the craters, with or without a central peak as the blow-out peters out, seems possible. The escape of gas trapped beneath the moon's loose 'sandy' surface would not necessarily require the high sub-surface temperatures associated with volcanic activity. Further it has recently been shown that shock-wave excitation of CO, CO_2 or CH_4 produces C_2 swan emission bands. Hence the reported C_2 emission spectrum from the 'Alphonse' crater may not necessarily indicate that the gas has a very high initial temperature.

Acoustoelectricity

The generation of an electric voltage in germanium by the passage of a very high frequency sound wave is being studied by G. Weinreich, of Bell Telephone Laboratories. The "Acoustoelectric" voltage difference appears along the direction of propagation of the wave, and is due to a net force forward acting on the charge carriers (electrons for example) within the germanium.

The effect is usually small, because of the normal electric repulsion between the carriers bunched by the wave. Examination of the conditions in which the effect is more marked sheds light on the energy states of the electrons in the germanium. Weinreich uses acoustic waves of 20 and 60 Mc./s. modulated at a much lower frequency to produce a fluctuating voltage output.—*The New Scientist*, January 8, 1959.

Molecular Sieves

Some of the naturally occurring mineral zeolites, such as analcite and chabazite, as well as some synthetic zeolites have in them an array of minute holes or micropores which are precisely of the same size which is comparable with the cross-section of organic molecules. These materials are known as molecular sieves because molecules of organic compounds, particularly hydrocarbons, having certain critical dimensions smaller than the pores of the zeolite, are capable of diffusing *into the pores* and remaining adsorbed while other hydrocarbons with larger dimensions cannot enter the pores and are merely adsorbed *upon the surface*. The critical dimension which controls the entry of the molecule is the largest diameter normal to the longest axis of the molecule. This for *n*-paraffins of moderate chain length is of the order of 5 Å, and Barrer has shown that by using a zeolite with pores of this size, *n*-paraffins may be separated quantitatively from their branched chain isomers which have a significantly larger cross-section. Other hydrocarbons

such as *cyclo*-paraffins, and aromatics are also too large to enter the pores and so can be separated from the *n*-paraffins. Commercial molecular sieves, of synthetic zeolites and silica powders, known as *sepa-gels* are now available in a range of pore sizes 4, 5, 10 and 13 Å, and are being used in organic molecular separation.

The technique is similar to conventional adsorption chromatography. The mixture of aromatics is allowed to flow slowly down a column packed with the molecular sieves adsorbent. This is followed by an elution with *iso*-octane which removes from the column those constituents which have not been adsorbed into the micropores. The portion which had suffered pore-adsorption may be desorbed by washing with a polar solvent such as ethanol at 75° C. Thus the original mixture of aromatics is separated into two fractions according to size, the smaller appearing in the ethanol eluate and the larger in the *iso*-octane eluate.

Other applications of molecular sieves are in gas chromatography and mass spectrometry where they may selectively restrict the entry of molecules into the instruments. (*Chemical Products*, January 1959.

Crude Oil Analysis Using Nuclear Reactor

Crude oil contains certain elements, such as vanadium, which are known to "poison" certain steps involved in petroleum refining. Generally the amount of these elements present in the crude oil is so small that the usual chemical methods of measuring them not only take time but also tend to depreciate in value because the supposedly pure test chemicals themselves contain enough of the unwanted elements to make the measurement unreliable. The Reactor method at the University of Michigan is arrived at permitting speedier and more accurate detection of such elements.

In this method a sample of the crude oil is sent through a pneumatic tube to the core of the reactor where in minutes it becomes radioactive. It is returned in a few seconds through the pneumatic tube for chemical analysis. The sample is immediately placed in a unique 100 channel analyzer, equipped with dual "memory", in which the radioactivity of the sample influences the instrument to draw a graph which will "finger-print" the element under investigation. A comparison of this "finger-print" with known graph of suspected elements will indicate the presence as well as the amount of the element in the crude oil.—*J. Frank. Inst.*, November 1958.

Pilobolus—*the Fungus with a "Lens"*

Phototropism, or the response to light, is common place in the plant world, but few more elegant examples are to be found than in the life of *Pilobolus*, the tiny 'ball-thrower' fungus. Growing on the droppings of grazing animals, the plant develops overnight and, by dawn, glistening colonies are found on the surface of the dung bits,—each individual composed of a delicate stalk (about quarter inch long) and a transparent, swollen subsporangium which is topped by the black 'ball' of its spore case. At sunrise, the swollen cell acts as a lens that concentrates light on a pigmented area of the stalk, and accelerated growth bends the plant toward the sun. Simultaneously, the pressure within this "lens" builds up—to as much as five atmospheres—until the cell bursts, casting the spore case as far as eight feet away. The flying 'ball' usually lands on a grass blade—to be eaten and voided by some grazing animal, whereupon *Pilobolus*' life-cycle starts once again.—*Natural History*, December 1958.

Ultrasonic Fatness Tests on Live Pigs

What is claimed to be an accurate, humane and simple method of measuring the thickness of fat on the back of live pigs is by the use of an ultrasonic probe. An ultrasonic sound wave is sent through the back fat of the pig, and on reaching the boundary between the fat and lean tissues, it is reflected back to the surface. The time taken for the sound waves to go through the fat and back again is a measure of the fat thickness. The ultrasonic probe which is placed on the pig's skin contains two barium titanate crystals. One sends out sound waves and the other receives the echo. The transmitting crystal is made to vibrate by the application of high-frequency electrical pulses of 2·5 Mc./s. The receiving crystal picks up the echo and converts the sound to electrical pulses. The crystals are connected by long leads to the main instrument where the transmitted and reflected pulses are amplified and displayed as narrow peaks on a cathode ray tube. The distance between peaks is proportional to the fat thickness.—*J. Frank. Inst.*, November 1958.

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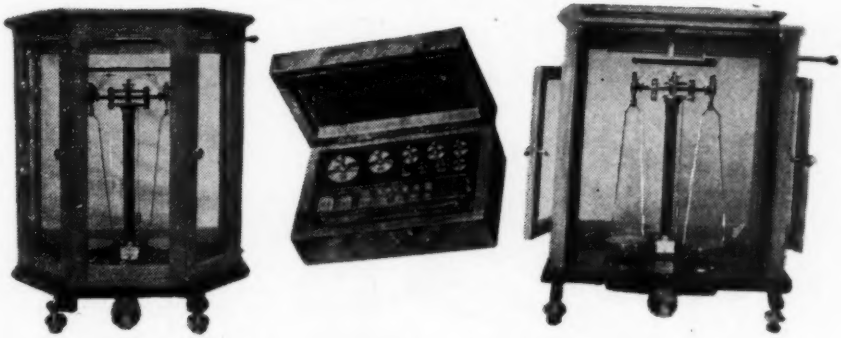

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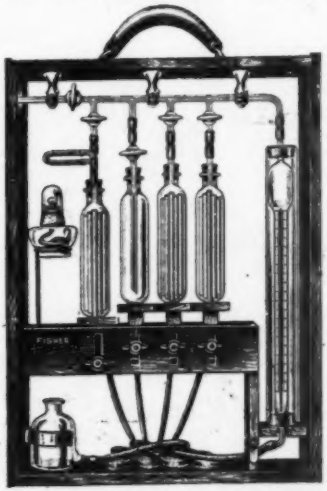

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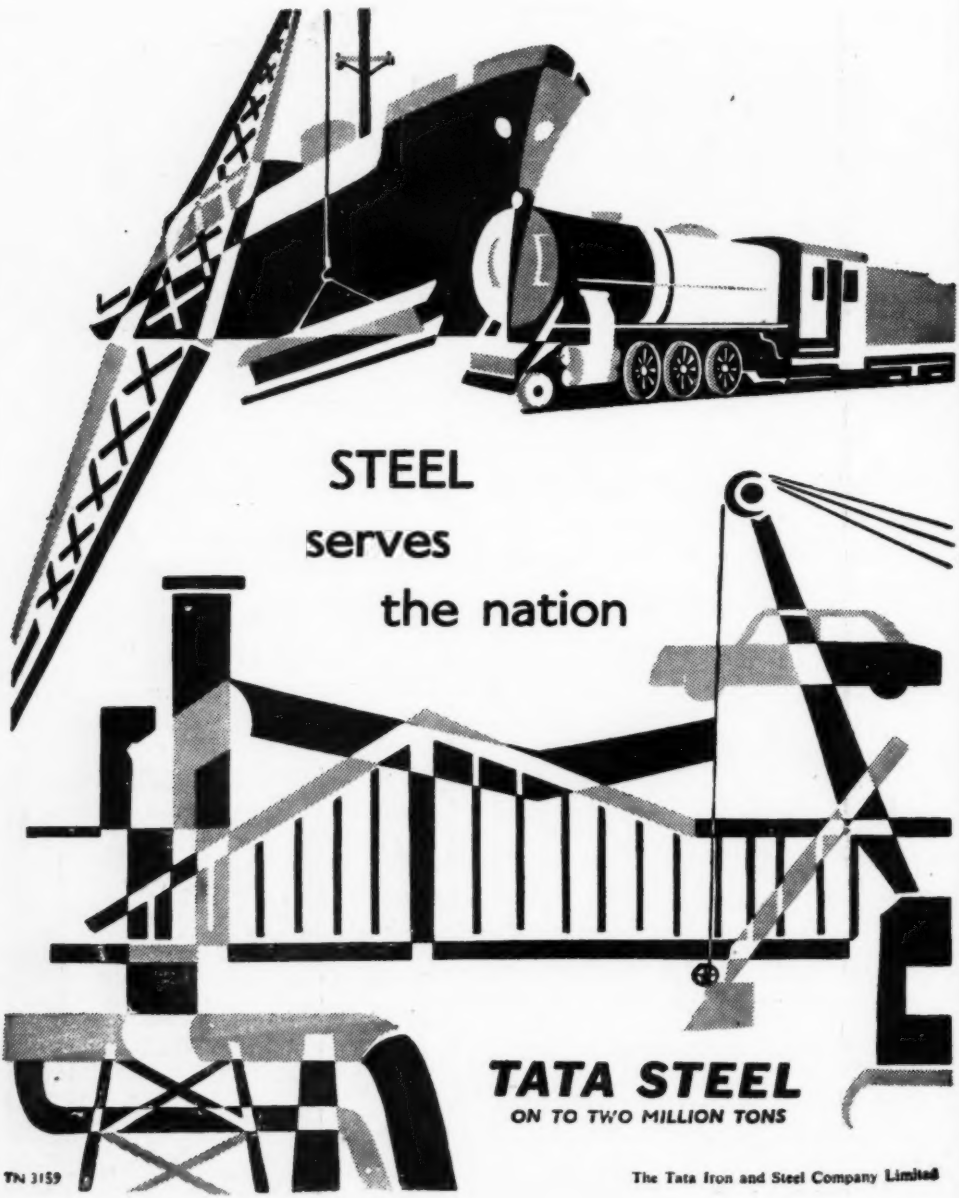
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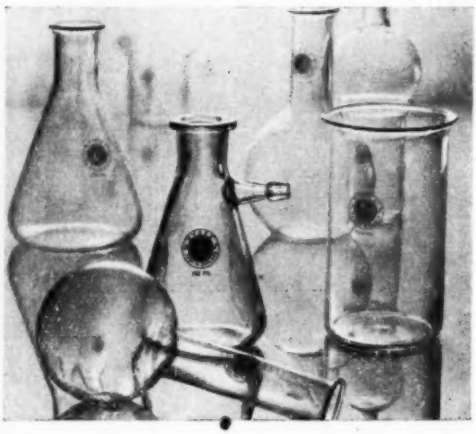

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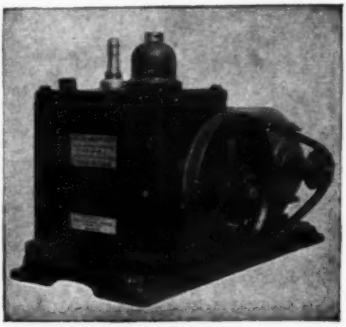

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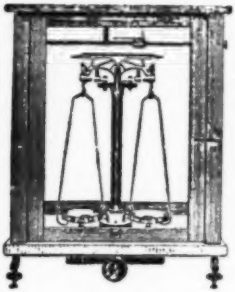

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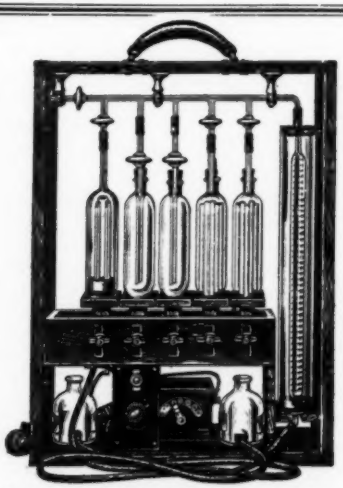

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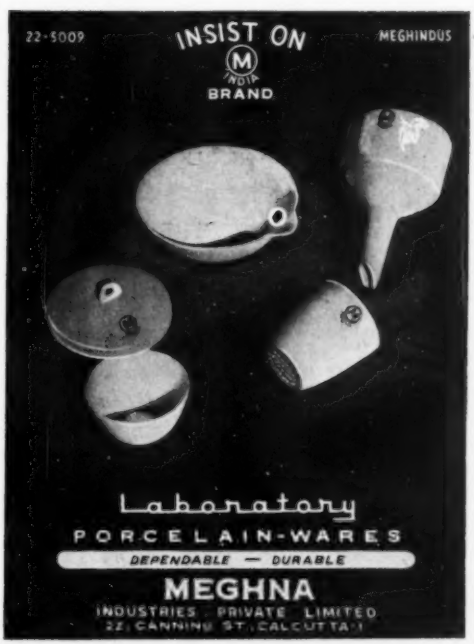

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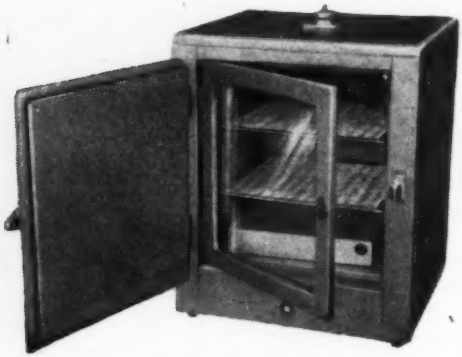

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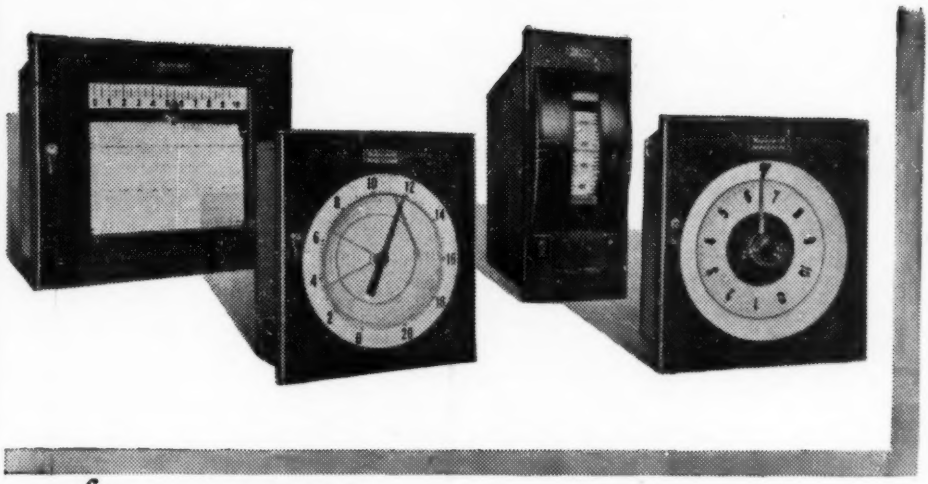

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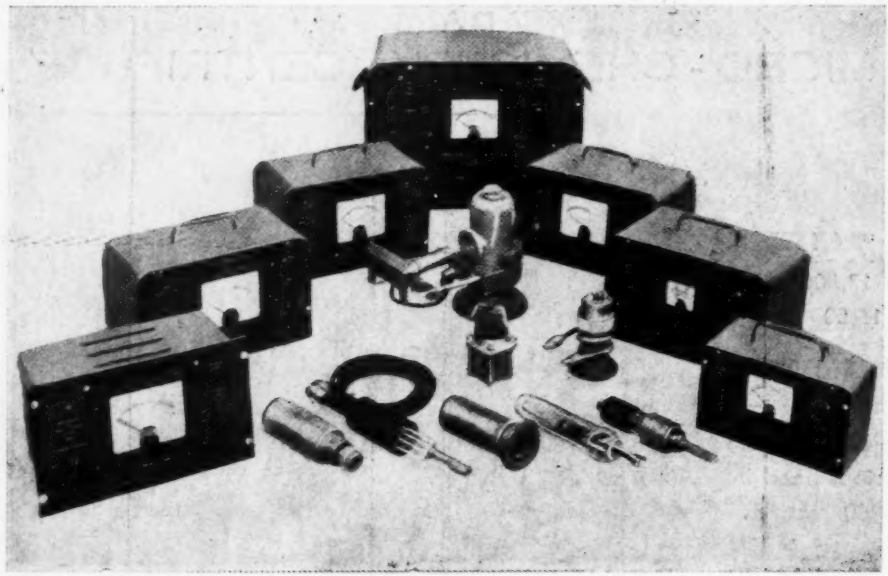

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